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THE · FIGHT · FOR SUPREMACY

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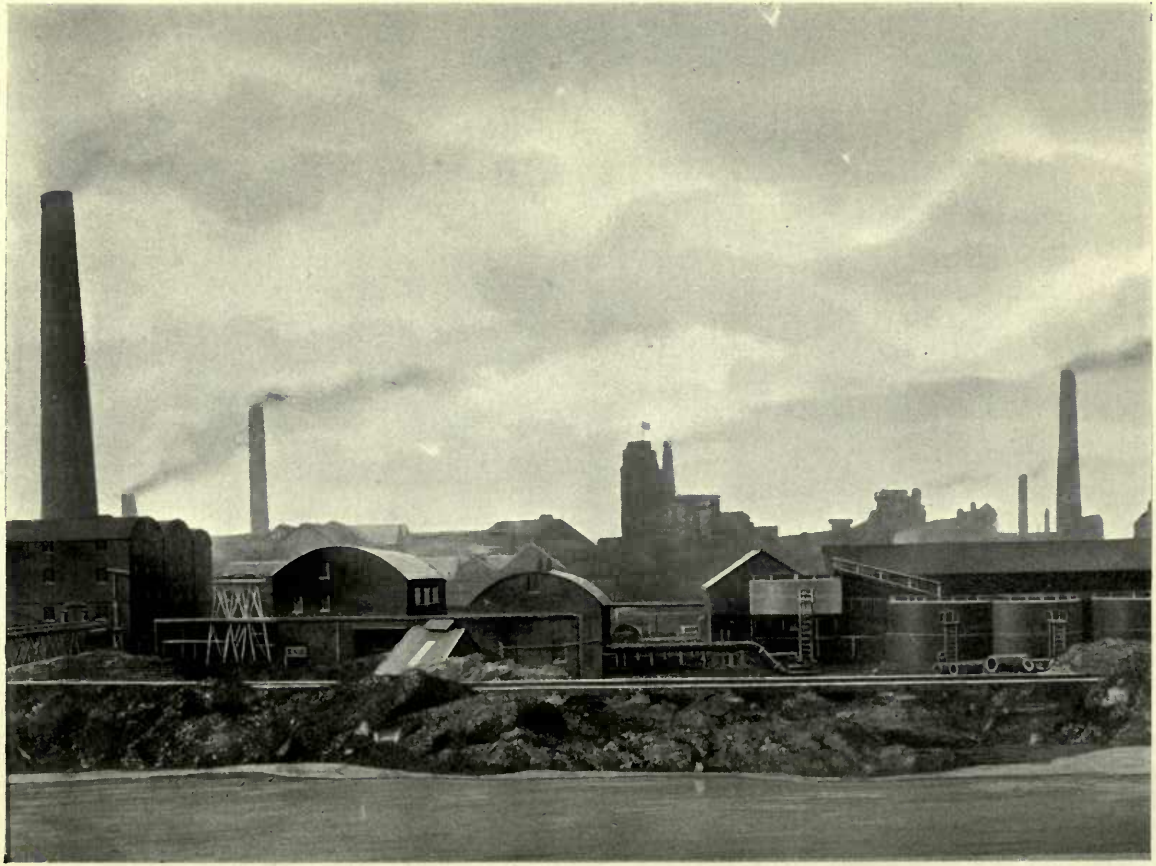
Allhusen Works, Gateshead, 1907.



ALLHUSEN WORKS, GATESHEAD, 1907.

Allhusen Works, Gateshead, 1907.

The approach to the Sotiel Coronada Mine, Prov. de Huelva.

THE STRUGGLE
FOR
SUPREMACY.

BEING A SERIES OF CHAPTERS IN THE HISTORY OF THE LEBLANC ALKALI INDUSTRY IN GREAT BRITAIN.

LIVERPOOL:
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1907.

TO THE READER.

THESE chapters upon the vicissitudes of one of the staple British industries appeared, under the title of

"THE STRUGGLE FOR SUPREMACY,"

in The Times of November 2nd, 9th, 12th, 14th, 19th, 21st and 26th, in the year 1906, and were written by a representative of that newspaper after a close personal investigation of the Mines, Works, Processes and Products of THE UNITED ALKALI COMPANY LIMITED.

THE design on the front cover is reproduced from a Medal struck to celebrate the erection, by international subscription, of a statue to Nicholas Leblanc in the Museum of Arts and Crafts in Paris, the unveiling of which took place on the 28th of June, 1887, practically one century after the discovery of the process which bears his name.

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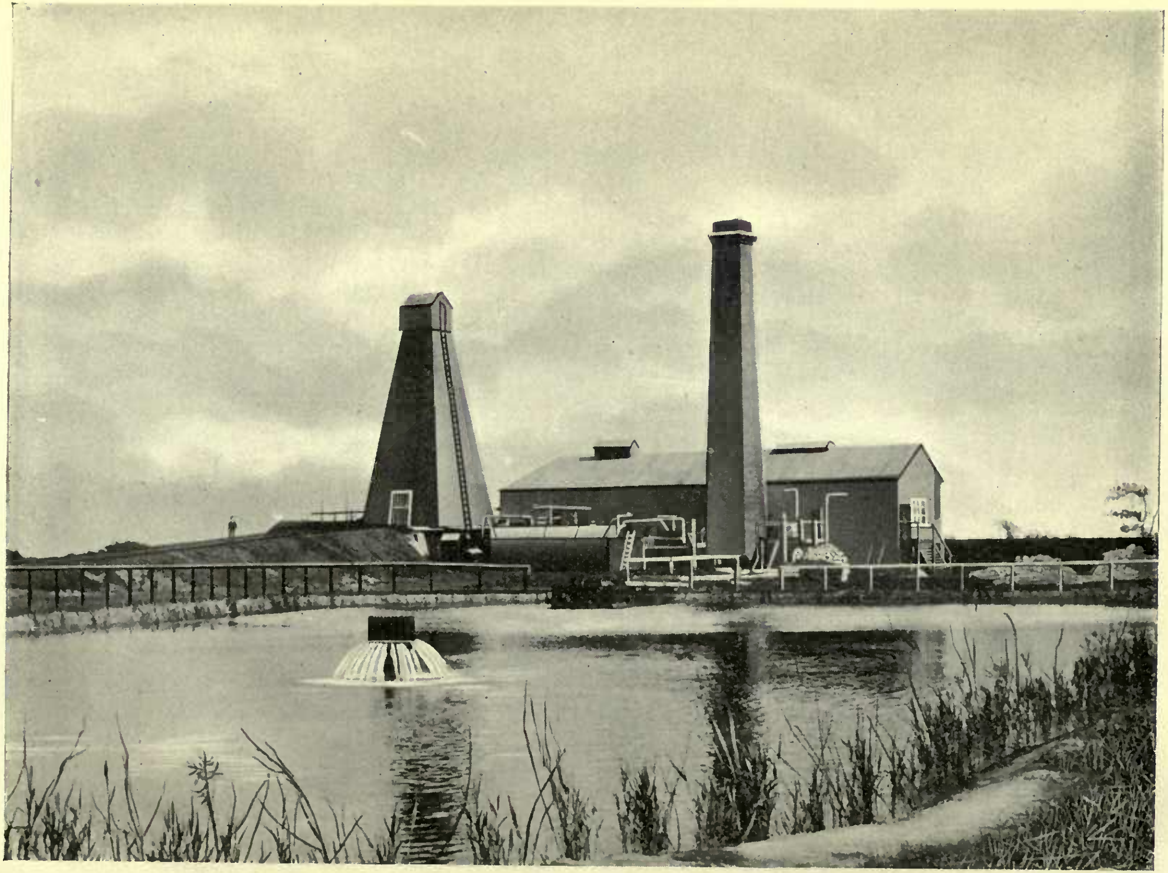


Pumping Station, Preesall Salt Works, Fleetwood.

Chapter I.

THE FOUNDATION-STONE OF A THOUSAND INDUSTRIES.

WHEN Lord Beaconsfield (then Mr. Disraeli) declared that the commercial prosperity of a country could be well gauged by the condition of the chemical trade, he was not only uttering one of those epigrammatic phrases for which he was famous, but also stating a fact of supreme importance. The extent to which the other great staple industries of this country depend, in some way or other, upon the soda-products of the Alkali Works is not easily realised by those to whom the subject is unfamiliar. The great textile industry, for instance, summons them to its aid at almost every stage in the manufacture of calico and other fabrics. Without them the process of bleaching would probably still be conducted in the old-fashioned expensive way, that is, by exposure of the pieces to sunlight and air.

Until bleaching powder was invented by Mr. Chas. Tennant, in 1799, and manufactured for over a century by him and his successors at St. Rollox, Glasgow (now one of the constituent works of The United Alkali Company), it was

customary to send goods requiring to be bleached to Holland or Germany, where a period of many months elapsed before the operation was complete. Now the same operation can be effected in a few hours. In the more recent invention of "mercerising," by which a silky sheen is imparted to cotton fabrics, the caustic soda of the alkali works is a necessary agent. The calico printing and glazing industry is yet another instance of dependence upon the products of the Alkali Works. Again, woollen textiles are, in their initial processes, indebted to the alkali-makers for the materials for cleansing and scouring the fleeces. The bleaching of animal matter, such as wool or silk, cannot be performed by bleaching powder, but must be effected by the fumes of burning sulphur, another valuable product of the works of THE UNITED ALKALI COMPANY. The great majority of textiles are dyed with colouring matters which cannot be produced without the aid of alkali, and the discovery and manufacture of the modern dyes form one of the most romantic stories in the history of the chemical industry. For the most part, the interesting and very profitable business of dye manufacture is conducted in Germany, and the way in which this delicate and highly-ingenious branch of scientific industry has been driven abroad, and almost crushed out of existence in this country by the inequality of our Patent Laws, and by certain other legislative restrictions, as well as by culpable ignorance in our places of higher education, will be discussed

in a later chapter. Meanwhile, it may be said that these disabling and hampering restrictions have been lately partially removed, our Patent Laws have been recently somewhat amended, and the opportunities for the highest scientific training vastly improved, though they still fall short of those of our commercial rivals.

The industrial battle is not yet waged upon a fair field with no favour, but the British Chemical Trade is at all events, not quite so heavily handicapped in its own country, and in its home markets as it was even six years ago.

The great textile industries are seen to have a close connexion with the alkali producers, but there are other staple trades even more dependent upon cheap soda than those above cited. Soap and glass cannot be manufactured without the aid of alkali in one or other of its forms, whilst all modern paper works are consumers of soda products, to the extent of some thousands of tons per annum. We could, no doubt, clothe ourselves in unbleached, unglazed, and unprinted calico, and even in undyed woollen garments, and still rub along quite comfortably. But without alkali, soap and glass would be impossible, and paper would be a luxury only obtainable by the rich. The universal use of soap is of comparatively recent growth. It has, of course, been known for generations that a weak lye (made by extracting the alkali from wood ashes) when boiled with fatty matter, would yield a soft soap. But this crudely prepared material was formerly subject in this

country to a heavy Excise duty of from 1d. to 3d. per lb. This impost, only repealed in 1853, naturally restricted the use of a substance which is now regarded as one of the prime necessities of life, and the phrase "the great unwashed" may have once had a greater significance than it possesses to-day. Cheap alkali means cheap soap, and anything therefore that tends to economical production of the former is reflected in the price of the latter, and hence (it is to be hoped) in the moral character of the consumers; for as some one has wittily said, "if cleanliness is next to godliness, then soap must be considered as a means of grace."

If the use of soap be credited with some measure of power in the elevation of the general standard of living, then glass is equally deserving of a share of credit in the uplifting of the artistic feeling of a nation. Glass is a touchstone of culture. Nothing is more indicative of refined taste in a household than the nature and quality of the glass vessels in daily use. There is an exquisite charm in finely cut glass which is not even approached by gold and silver. Its crystalline sparkle adds a refinement of real but intangible character to a meal which may be far from elaborate. The eye and the sense of touch, and even the palate are all gratified by the bright and delicate material which serves equally for adornment as for use. No wine tastes so good from any earthen or metal vessel as from a goblet of thin, transparent, shimmering glass.

Boots might as readily be made without leather as glass without alkali. The kindred industry of porcelain manufacture offers another instance of reliance upon the alkali maker for most of its finer productions. The glazes and enamels of the highest phases of the ceramic art depend upon the chemical combination of the silica in the clay with the soda of the alkali.

Agriculture is rapidly becoming a branch of chemical science, and the soil is now largely regarded by scientific men as merely a vehicle for the conveyance to the plant of artifically prepared nutrition. THE UNITED ALKALI COMPANY manufactures enormous quantities of fertilizers whose relation to the production of alkali will be dealt with in its proper place.

It is scarcely possible to touch upon any industry which is independent of alkaline products. The tanner, for example, who for ages has soaked his raw hides in lime to detach the hair or wool, now finds that sulphide of sodium performs the same function in a fraction of the time required by the more ancient process.

Since the introduction of the treatment of the "tailings" in the South African gold mines by the "cyanide process," a great demand has sprung up for the cyanide of sodium which has the remarkable power of dissolving gold. The finely-divided state of the gold in the blanket ore raised from the Transvaal mines, resulted in much loss of the precious metal when treated by the usual methods. The above-named process has rendered

it possible, however, to extract practically the whole of the gold without sensible loss. The unexpected demand, since 1887, for this poisonous cyanide, which was formerly little more than a laboratory reagent prepared in trifling quantities, has stimulated the inventive powers of all modern chemists, and, in the battle of brains and technical skill, it is gratifying to know that a remarkably successful process for the preparation, on a vast commercial scale, of this deadly but useful poison has been worked out in the central laboratory of THE UNITED ALKALI COMPANY at Widnes, and patented by its inventors, and that this process is now recognised as one of the most economical methods hitherto devised of preparing "cyanide." Further details of this latest stroke in the industrial duel will be given in a future chapter.

In every home the products of the Alkali Works find a place. The most familiar substance in daily use is, perhaps, the crystalline carbonate of soda, known as "washing soda." Every scullerymaid is acquainted with this cheap and useful article as an essential in cleansing greasy vessels, or in washing soiled fabrics in which the dirt is deeply engrained. "Soda" has also the effect of "softening" very hard water, and it is now an indispensable requisite in all households. Though the individual purchases may appear small, the total weight of soda crystals manufactured and sold in 1905 by THE UNITED ALKALI COMPANY amounted to about one-half the total quantity manufactured in the United Kingdom.

Soda Crystals, or Washing Soda.

Extract of soap, or dry soap, so extensively used for rougher scouring purposes, contains a large proportion of "soda ash" (that is the same material as the crystals, but in the form of a desiccated powder), whilst the popular "cleansers," for polishing pots and pans, contain a considerable quantity of caustic alkali.

In baking powder, and in the familiar "bi-carbonate of soda" used in production of carbonic acid gas for aerated waters, the product of the alkali manufacturer comes again very closely into daily life. The washing "blue" employed in every laundry, to correct the yellow tinge which boiled linen is apt to assume, is another product of the Alkali Works. This artificial and soluble ultramarine is merely a compound of soda ash, saltcake, sulphur and clay, subjected to the action of great heat. Large quantities of this extraordinary chemical product are consumed by the paper manufacturers, who need it for exactly the same purpose as the washerwoman, viz., to neutralise the yellowish colour of their materials, and thus give the optical effect of whiteness. Even sugar refiners are known to secure the same end by the same means. Again, the "water" paints now in such common use for covering walls and other extensive surfaces contain a silicate of soda manufactured in very large quantities by THE UNITED ALKALI COMPANY at their works at Widnes and Newcastle.

The photographer when he employs his "hypo" in such lavish quantities lays the Alkali

Works under contribution, and has them to thank for the economical methods whereby the production of this useful substance has been rendered so cheap as to bring it within the reach of the humblest amateur.

The science of medicine relies, perhaps even too much, upon the chemists, and the compounds in which bicarbonate of soda is present, form no small part of the contents of the battery of bottles upon a druggist's shelves.

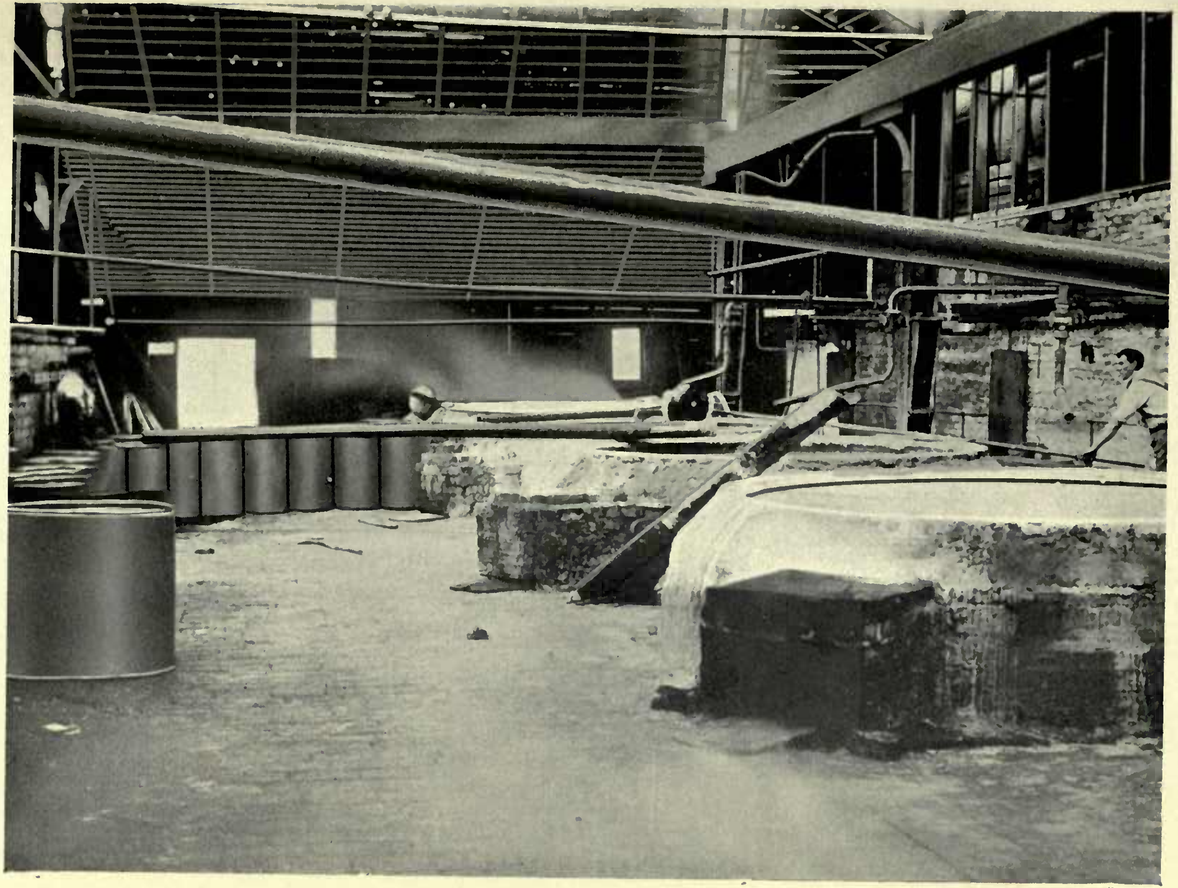
In other branches of chemical industry, in the manufacture of metallic aluminium, in the preparation of dyes, paints, and other colouring matters, explosives, disinfectants, enamels, &c., alkali, in one form or another, in an essential ingredient. In fact, it is not too much to say that the use of alkali is co-extensive with the area of commercial activity. When one reflects that the raw materials from which all the products of the many works of this great company are prepared are nothing more than limestone, clay, salt, coal, and low-grade copper ore rich in sulphur, it will at once be seen that an immense amount of inventive ingenuity must have been expended to create great and complex industries out of the chemical interchanges possible amongst such rough and seemingly unpromising materials. These raw substances are not in the monopoly of any one country; they are found almost everywhere. It is open to the whole world to engage in the manufacture of alkali, and as it is of such universal use there is a market for it everywhere. This

country has a rich heritage. No other nation has produced such a wealth of inventive genius in the domain of industrial achievement. It is, therefore, interesting to know that in the struggle for supremacy in the alkali trade the apparatus and the processes invented by our countrymen have, with very few exceptions, set the standard for the rest of the world, just as truly as in the textile and engineering trades. Cheap alkali is a prime necessity. Dear alkali means dearer soap, dearer glass, dearer calico, and a rise in the cost of a thousand other products. The industrial battle in which the brains and skill of the manufacturing chemists of this country are being pitted against those of our commercial rivals in the preparation of this all important product, the raw material of so many other industries, though the scene of conflict is amongst the unsavoury chemical works of the Mersey, the Tyne, and the Clyde, possesses a lively interest, and even a romance, for all those to whom the industrial welfare of this country closely appeals.

Chapter II.

THE RISE OF THE ALKALI INDUSTRY.

IN the year 1806, in dire poverty, there perished miserably by his own hand, a man to whose genius one of the greatest of the industries of this country stands as an imperishable monument. This man was Nicholas Leblanc, who, according to the *Encyclopædia Britannica* was private surgeon to the Duc d'Orleans. In 1775, Leblanc, who was then only 22 years of age, was attracted by the prize of 2,400 livres (about £100) offered by the French Academy of Sciences for a practical means of converting common salt into soda. Though little more than an apothecary, Leblanc had greedily imbibed the scanty chemical knowledge of his time, and thirsted for conquests of his own in that recently discovered domain. Modern chemistry dates from the discovery of oxygen, and when Leblanc began his researches, this discovery (made almost simultaneously in England by Priestley of Birmingham, and in Sweden by Scheele) was barely two years old. The French



Caustic Soda Manufacture

nobleman, Lavoisier, director of the government gunpowder factories, who perished later at the guillotine during the Reign of Terror, had just examined this newly-discovered body, and had given to it the name by which it was henceforth to be known—Oxygen. In 1774, Scheele further announced to the world his illustrious discovery of chlorine, which, in the cumbersome nomenclature of the time, he designated "dephlogisticated marine acid air," and he showed that this body was one of the constituents of common salt.

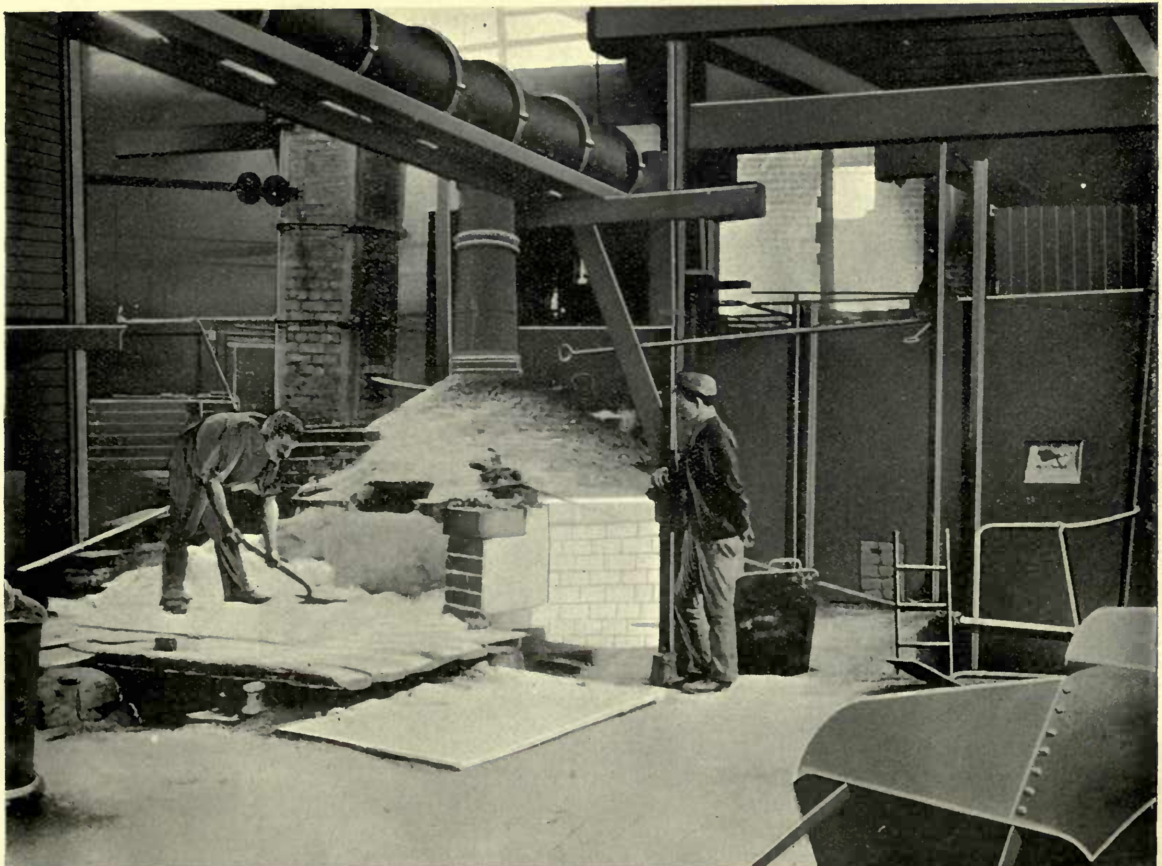
The Academy of Sciences had long suspected that natural alkali and common salt had some element in common, a theory which later research has proved to be true. Hence the offer of so valuable a prize for some practical means of turning salt into "soda." The uses of alkali, described in the last chapter, were so important, even as far back as the eighteenth century, that some means of cheapening its production were eagerly sought for, as large quantities were required in the manufacture of glass and soap, paper, and glazes for porcelain, &c.

The alkali "soda" is the magical agent by the operation of which things common, and even despised, such as rags, wood, sand and animal fats are converted into substances of the highest value in daily and domestic life. The ancients, probably, did not know soda in other than its native mineral forms, and, until Leblanc's time, the alkali now known as potash was the more abundant and generally used substance. This alkaline agent

was obtained by the evaporation of water in which wood ashes (pot-ashes) had been boiled. The early chemists had not realised that there was any intrinsic difference between the two alkalies, and they spoke of them indifferently as Natron, Nitrum, Kali, Alkali and Soda, names simply meaning a fixed alkali. It is now known that soda and potash are the hydroxides of two strangely similar metals —sodium and potassium. Gradual destruction of the forests made potash scarce just when the population of Europe was increasing, and the demand for paper, glass, soap, porcelain, &c., was growing beyond the means of production. Hence the government of Louis XVI. offered the prize above named.

In Leblanc's time one of the chief sources of alkali was from the ashes of seaweeds. By the incineration of these plants a residue was obtained which contained about 50 per cent. of alkali (sodium carbonate), and the preparation and sale of this crude "barilla" formed a considerable industry on many sea coasts, especially round the Mediterranean. On the western shores of Scotland and Ireland for generations it was also the custom of the peasantry to collect the weed cast up by the winter storms, to burn it, and send the ashes to Glasgow, there to have the alkali and the still more valuable iodine extracted.

The trade in barilla with this country is now practically extinguished, though as late as 1834 no less than 12,000 tons of this substance were shipped to England from Spain alone. But barilla



Saltcake Manufacture.—The Salt being charged into the "Saltcake Pot."

or vegetable alkali was expensive and impure, and the supply insufficient for the needs of the trades and arts dependent upon it.

Therefore the necessity of solving the problem of how to convert salt into soda. Of salt there were limitless quantities, and any practical process by which this substance could be transmuted into the much desired alkali promised to bring fame and fortune to its inventor. The chemist of 120 years ago had very few implements with which to engage upon scientific research. Sulphur and nitre (saltpetre), with their kindred acids "oil of vitriol" (sulphuric acid) and "aqua fortis" (nitric acid) where the chief transmuting reagents known to 18th century chemists. Stills and crucibles were used, though their expense and imperfect construction were a constant source of trouble to the chemist, or alchemist, as he was still frequently called. Leblanc, led by genius, or by some marvellous instinct, first treated the common salt with sulphuric acid. To use modern phraseology, he thereby decomposed the salt and produced a sulphate of soda, commercially styled "saltcake." In this process of decomposition prodigious fumes are given off, formerly called muriatic acid, but now always called hydrochloric acid gas, and the discovery of the enormous but unsuspected value of this waste product will be referred to later, as it forms an interesting incident in British chemistry, well illustrating the principle that to the chemist there is no such thing as a waste material. Leblanc's genius is most apparent in the second

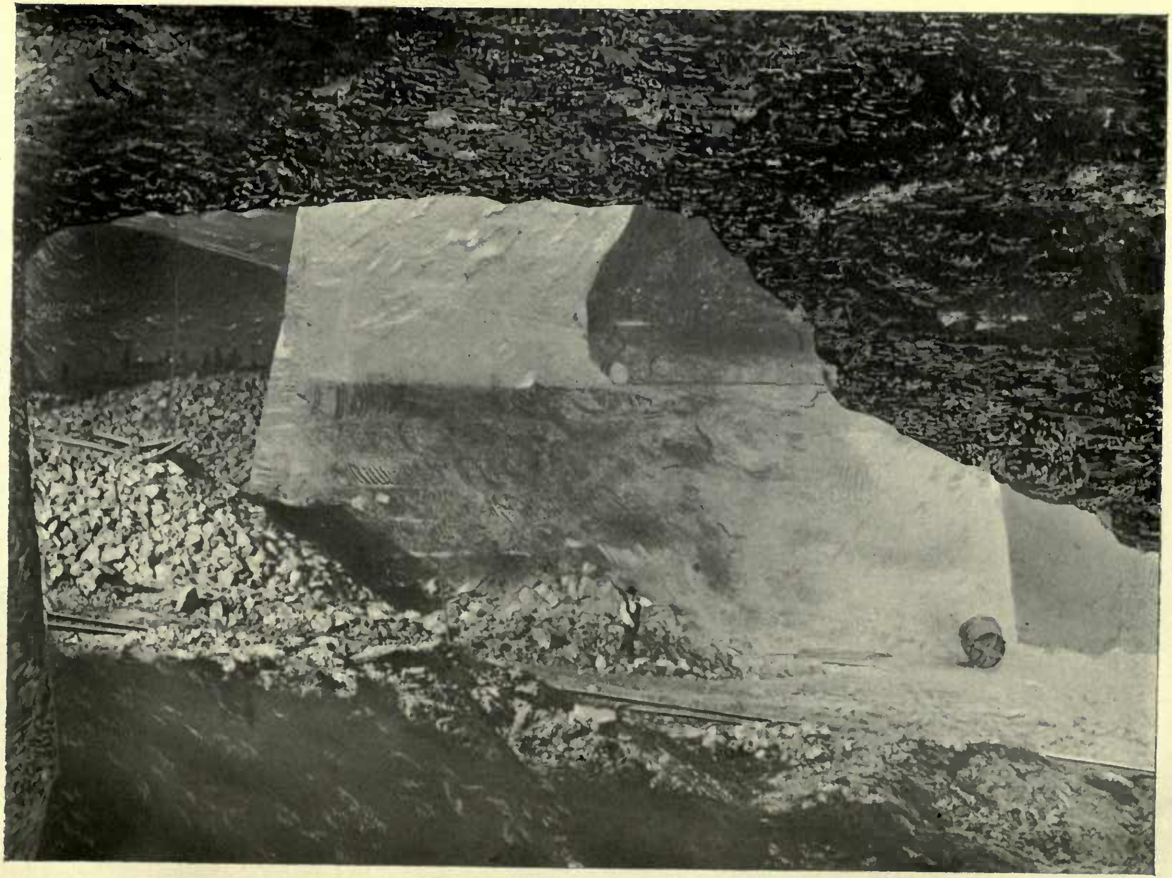
stage of his invention, viz., the turning of saltcake into soda. He here struck upon an idea which had excited the admiration of all his followers. To the saltcake he added charcoal and chalk; and then by strongly heating the ingredients in a crucible he succeeded in effecting the desired transformation. The black mass when cool was lixiviated, that is, stirred up with water, whereupon the alkali dissolved out and a heavy, grey, muddy sediment remained. This sediment, known as "tank, vat, or alkali waste," is the chief constituent of the gigantic refuse heaps found near the older chemical works. In the next chapter it will be seen how, after innumerable experiments by many chemists, this "waste product" has been turned into a source of wealth. The great prize was never awarded; for the French Revolution had already set in, and Leblanc's hopes of prosperity were blighted. In September, 1791, the National Assembly granted him a patent for 15 years; but in 1794 Leblanc was ordered to resign his factory to the Republic for the general benefit, and for this he received the miserable compensation of £160. In 1800 his factory was reconveyed to him, but in 1806, broken in hope, health, spirit, and resource, he perished, as above stated.

Leblanc's invention stands distinguished in the annals of industry, not only as by far the most important achievement among chemico-industrial inventions, but also as having been "created perfect." In the words of a distinguished chemist, himself a discoverer of high order, the late

Professor A. W. Hofmann, "all other great chemical industries have been slowly worked out by the toil of successive inventors, but Leblanc's process remains to-day what it was when he first gave it to the world—the best and simplest method of effecting the most valuable of transformations." Though innumerable researches have been made with a view to its improvement, and though the mechanical means of dealing with the materials have been vastly improved, and though the by-products thrown off during the reactions are now carefully collected and utilised in a way of which Leblanc never dreamed, the fact remains that his original instructions are followed out with merely a few comparatively unimportant modifications. This ever-memorable discovery of the ingenious but unfortunate Leblanc, the creator of incalculable wealth for his fellow-men, is still largely employed, and for over fifty years no other process for manufacturing alkali was used in Great Britain. At the period of Leblanc's invention, there was a duty in this country of £10 per ton on salt. During the Napoleonic struggle this was raised as a war tax to £30 per ton, which rate was continued until 1823, when the duty was repealed. The year 1823 may, therefore, be considered as the natal year of the soda industry as a special manufacture in Great Britain, and the county of Lancashire has been the first and chief home of the alkali trade since common salt was relieved of the burdensome impost. In the self-same year, Mr. James Muspratt, father of the present

Vice-Chairman of THE UNITED ALKALI COMPANY, erected works in Liverpool for the manufacture of carbonate of soda, where he adopted Leblanc's process in its entirety.

Until 1872 the Leblanc process of manufacturing soda held its own. But the progress of scientific achievement cannot be stayed, and in the early "seventies" another and utterly different method of preparing alkali was developed on a commercial scale, and has now largely replaced the older method. This is known as the ammonia-soda process, associated with the name of the Belgian engineer, Ernest Solvay. Although it is sometimes referred to as "the new process," it is in its inception hardly more modern than that of Leblanc, the great difference being, as Hofmann said, that the latter was "created perfect," whilst the ammonia process has been built up by accretion of experiment and invention. Solvay, himself, generously says that the first truly industrial application of the ammonia process is due to two London chemists, Messrs. Dyar and Hemming, who took out a patent in 1838 for their invention. Somewhat later, the Mr. James Muspratt above-named, established the ammonia-soda process in Lancashire, and it may not be generally known that Henry Deacon, one of the founders of the Gaskell Deacon Works at Widnes (one of the 47 chemical works associated under the name of THE UNITED ALKALI COMPANY), before the erection of his works for the manufacture of soda by the Leblanc process, used the ammonia-soda



Rock Salt Mine, shewing Section of Workings.

process for about two years, producing several tons a day; but, owing to engineering difficulties, he abandoned this method of preparing alkali in favour of the Leblanc system. It is in the mechanism, apparatus and appliances necessary for the successful use of this process that Solvay will be remembered, and not as an inventor of the process itself. The chemical transformation, which will be described in a future chapter, was known almost before Solvay was born, but to Solvay is rightly due the honour of making the process commercially successful.

The process has these enormous advantages, that it leaves practically no solid residue, and that it requires singularly little fuel, less than half of that used in the Leblanc process. Simple as the process is it presented tremendous mechanical difficulties, which Solvay's ingenious inventions finally overcame. The "Solvay" ammonia process was introduced at Northwich in 1872 by Dr. Ludwig Mond, the celebrated chemist and inventor, to whose enlightened philanthropy we owe the Davey-Faraday Research Laboratory of the Royal Institution, founded and endowed by Dr. Mond in 1896. The ultimate result has been that the ammonia process established at Northwich directly above the salt deposits has assumed enormous proportions, and has revolutionised the alkali trade of Great Britain, and largely supplanted the classic method of Leblanc for producing the carbonates of soda. Further details of this economical system will be given when the

great salt mines of THE UNITED ALKALI COMPANY near Fleetwood, and the ammonia soda works at the same place pass under review. It may well be asked how the historic Leblanc system can continue to exist in the presence of the newer and cheaper process. The answer is afforded by the value of those waste products to which frequent reference has already been made. The acid fumes given off in the first stage of Leblanc's system furnish the basis of the manufacture of bleaching powder and chlorates, in fact, these by-products are more valuable than the alkali (sodium carbonate) itself.

The grey muddy residue obtained in the second stage of the Leblanc process has also been converted to profit by causing it to yield up the sulphur which it contains in a state so perfectly pure that it commands the highest market price, and is superior even to the famous Sicilian product.

Thus, by utilising waste products cast aside as useless by a former generation, the modern manufacturer turns the famous but ancient Leblanc process to good account. The price of alkali has naturally fallen with the advance of the industry, especially since the introduction of the Solvay process. In 1800 the price of soda crystals, then manufactured from the ashes of seaweed, was £60 per ton. When Mr. Muspratt commenced operations his soda crystals were sold at £18 per ton, and soda ash at £24. To-day the first quality soda crystals may be purchased, free on board at Liverpool, at £3 7s. 6d. per ton.

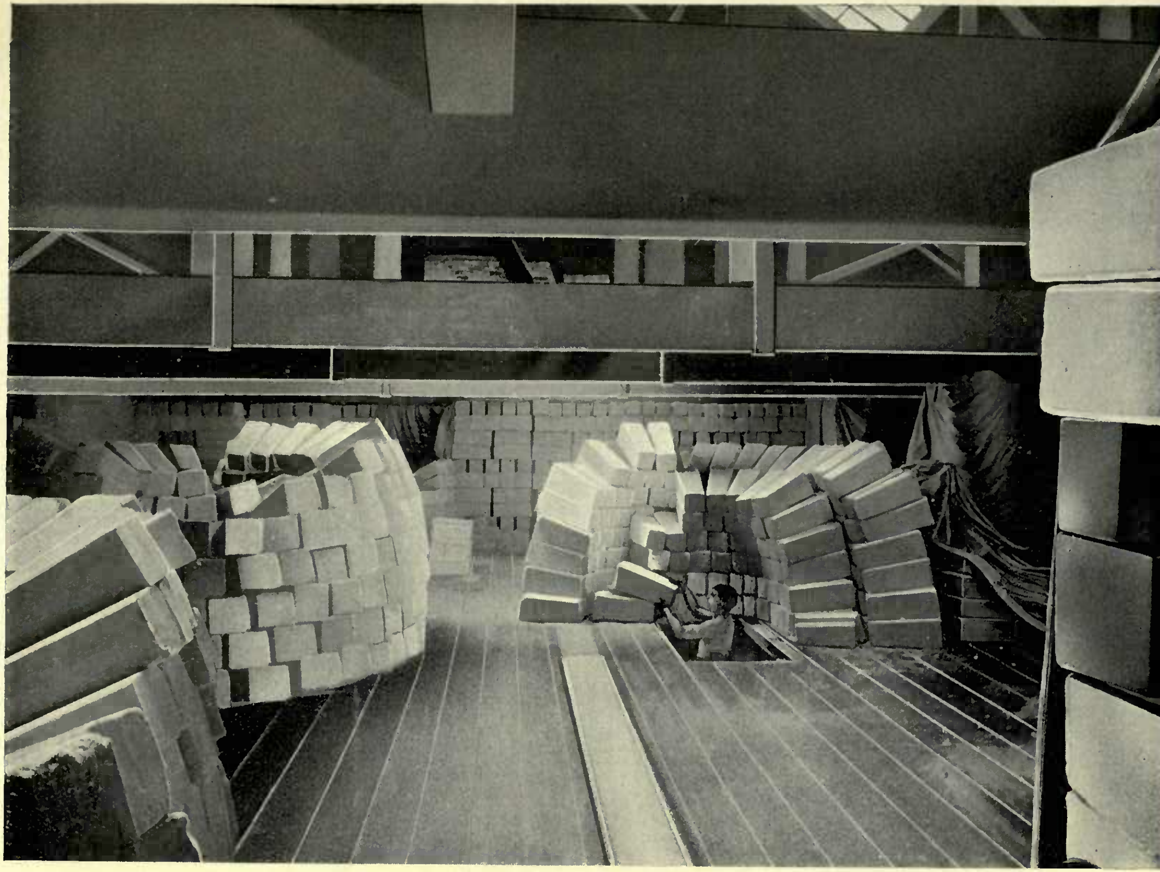
Chapter III.

WEALTH FROM WASTE.

POSSIBLY in no department of chemical science has the practical genius of the British chemist been more apparent than in the profitable utilisation of the materials thrown aside as waste in the processes of manufacture of some chief product. The coal-tar colour industry furnishes an illustrious example of this remarkable instinct of perceiving potentialities in the most unpromising material. Before Sir William Perkins's epoch-making discovery of mauve, the jubilee of which has lately been celebrated (see *The Times* of July 27th, 1906), coal-tar was looked upon as a necessary but evil accompaniment of the distillation of coal during the manufacture of coal gas, and large sums were paid to have the noxious stuff carted away, buried or burnt.

It was seen in the last chapter that Leblanc's ingenious process, for the conversion of salt into soda, yielded two products which were looked upon by him, and for many years by his successors, as unavoidable wastes, nuisances inseparable from

the manufacture of soda. The one was a fuming acid gas, thrown off in enormous volumes at the moment when the sulphuric acid comes into contact with the common salt; the other was a grey, muddy sediment with an offensive smell. The first of these, now always called hydrochloric acid gas, was allowed to escape into the air, with the result that it devastated the neighbourhood, killing off all vegetation by its corroding action. In the early days of the soda trade no attempt was made to condense these tremendous fumes, and, so long as the extent of manufacture was small, the inconvenience was borne by the neighbouring public, but in 1823, after the abolition of the salt tax, when Mr. James Muspratt, senior, erected works in Liverpool for the manufacture of soda by Leblanc's process, matters reached a crisis. The noxious gas was evolved from Mr. Muspratt's chimneys in torrents beyond endurance, and Liverpool rose in revolt. Ultimately the Corporation compelled Mr. Muspratt to remove his works to Newton. This caused the attention of practical men to be turned to the subject of utilising this waste product. The difficulty arose chiefly from the immense volumes of gas to be dealt with. Though a man of remarkable enterprise and foresight, Mr. Muspratt was sceptical as to the possibility of condensing the prodigious quantity of vapour, and when an invention for the purpose of absorbing the hydrochloric acid gas by means of water was submitted to him by Mr. William Gossage, Mr. Muspratt retorted that "not



Salt for Domestic Consumption.

all the water in the falls of Ballyshannon would condense the gas from his works." Nevertheless, in 1836, Mr. Gossage completely solved the problem by devising the now familiar "condensing towers," in which a descending stream of water meets and absorbs the ascending fumes; and so successfully did "Gossage's towers" perform their task that, in the Alkali Act of 1863, the government made it incumbent upon all Alkali manufacturers to condense 95 per cent. of their hydrochloric acid fume. In actual practice, since the value of this "waste" gas has been demonstrated, the condensation is so complete that only a trace of the obnoxious acid fumes escapes into the atmosphere.

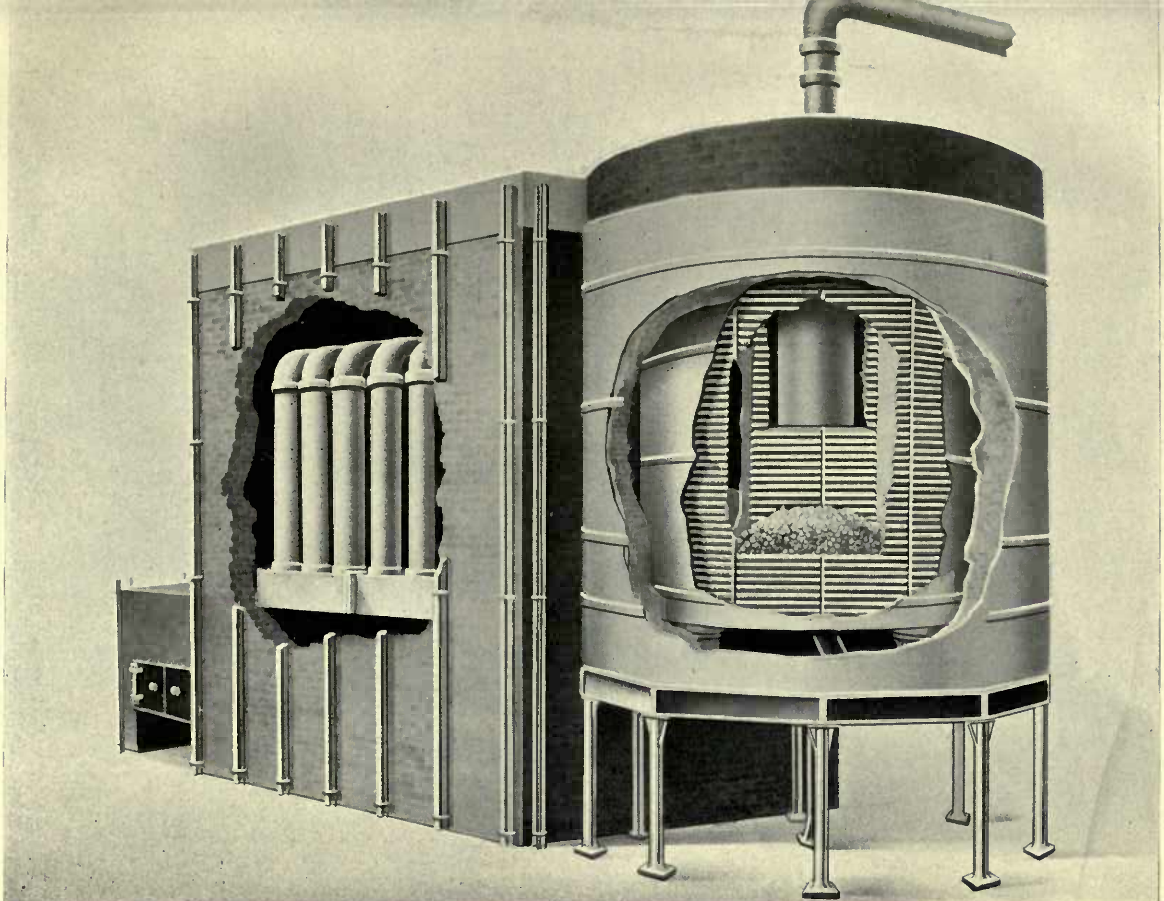
Hydrochloric acid contains only two elements, hydrogen and chlorine. Of these chlorine is commercially the important member. About ten years after its discovery it was found to possess most astonishing bleaching properties. In April, 1785, before the French Academy of Sciences in Paris, the famous chemist Berthollet read a paper which was published in the *Journal de Physique* for May of the same year. He there mentions that he had tried the effect of the gas in bleaching cloth, and found that it answered perfectly. This at once set upon its track certain enterprising active-minded people, who foresaw great potentialities in this heavy, offensive, green gaseous body. In 1786 the celebrated James Watt, inventor of the modern condensing steam engine, visited Paris, and there Berthollet exhibited his experiments to

his distinguished fellow-scientist and inventor. On returning to England Watt commenced a practical examination of the subject, and was accordingly the first man to introduce bleaching by chlorine into this country. The commercial practice of this now universal method of whitening cotton goods was first tried in some bleach yards near Glasgow, the property of a Mr. Macgregor, Watt's father-in-law. The new process could accomplish in a few hours what had hitherto taken open-air exposure during a whole summer to effect. The records of the time show that it was regarded as an amazing feat that 1,400 pieces of gray muslin despatched on Tuesday to the bleachers were returned on Thursday to the manufacturers bleached and finished and ready for immediate use.

In early days chlorine gas was prepared by heating a mixture of common salt and black oxide of manganese with "oil of vitriol" (sulphuric acid). The gas for the purpose of bleaching was simply dissolved in water; but in this form its use was attended with grave harm to the workmen. This was partly remedied by the addition of potash to the water, producing a bleaching solution called "Eau de Javelle" by its first makers. The most important advance, however, was to absorb the gas in finely divided slaked lime. This was the idea of Mr. Chas. Tennant, of St. Rollox, Glasgow, grandfather of the late Sir Chas. Tennant, Bart., president of The United Alkali Company. On the 13th April, 1799, Mr. Tennant obtained a patent for the manufacture of chloride of lime in a

state of powder. This simple but effective process laid the foundations of a huge and ever-extending industry, and the St. Rollox Works, which began in a small way over a century ago, were for a long time the largest manufactory of bleaching powder in the world. The preparation of chlorine as described above was expensive, chiefly owing to the residues which ran to waste, carrying off with them all the manganese and two-thirds of the chlorine. To recover these lost products was indeed a problem well worthy of attention. To the ardent chemist the word "waste" is like the proverbial red rag to the bull. There is no such thing as waste. It is only matter misunderstood, misapplied, and in the wrong place. The problem was ultimately solved in 1869, by Mr. Walter Weldon, of London, who, after long-continued devotion of time, labour and money, perfected an ingenious and cheap process for the recovery of the manganese. With the friendly assistance of Sir David Gamble, Bart., C.B., Vice-President of THE UNITED ALKALI COMPANY, the "Weldon Manganese Recovery Process" was first practised in the works of Messrs. J. C. Gamble and Sons, at St. Helens (one of the constituent firms comprised in THE UNITED ALKALI COMPANY), and at once practically revolutionised the bleaching powder manufacture by largely reducing the cost of production. The work of this ingenious English inventor, who died in 1885 at the early age of 52, offers another instance of the discovery of latent wealth in so-called "waste."

Though Weldon's invention obviated the loss of manganese, it did not recover that portion of the chlorine which was still finding its way down the drain pipes in the shape of calcium chloride. The extensive loss of so valuable an element could not long be tolerated, and in 1870 the late Mr. Henry Deacon, one of the founders of the firm of Gaskell, Deacon & Co., of Widnes (now incorporated in THE UNITED ALKALI COMPANY), devised, with the co-operation of his brilliant assistant, Dr. Ferdinand Hurter, a remarkable and very scientific means for the preparation of chlorine without any use whatever of manganese, in which also *all* the chlorine in the salt is recovered. This was the Mr. Deacon who, as related in the last chapter, was actually working as far back as 1853 the famous "new" soda-ammonia process. Deacon's invention gave an immediate additional value to those troublesome fumes of hydrochloric acid which, as described, had been the bugbear of the early alkali manufacturers. The process, like all great inventions, is in its essence extremely simple, but, like many other successful experiments, it failed to act when first applied on the large scale necessary for commercial purposes. The laboratory method consisted of passing pure hydrochloric acid gas over heated copper salts at a given temperature. The gas was decomposed into its elements. Chlorine was evolved, and the copper salts appeared to be inexhaustively active; but on the large scale how different! The small *impurities* in the vast quantities of the fuming gas quite



The Deacon Chlorine Process.—Superheater and Decomposer.

upset all the calculations, with the result that the majority of those who adopted the process gave it up in despair, and for a quarter of a century it did not make much headway. But patience and perseverance have finally overcome the technical difficulties, and have rendered the "Deacon" process the cheapest means in existence for producing chlorine from hydrochloric acid, and THE UNITED ALKALI COMPANY the largest chlorine product manufacturers in the world. Thus, after many years, the first stage of the classical Leblanc process was rounded off by the complete and profitable utilisation of all "waste" material thrown off during the manufacture of saltcake.

It will be remembered that in the second stage of the famous Leblanc process a grey muddy sediment remained, which up to recent years was cast away and dumped in ever-growing hillocks outside the chemical works, there to yield, when soaked with rain, exhalations offensive to the nose and drainings poisonous to the neighbouring streams. It may now be briefly described how British chemists have extracted wealth from this waste, and at the same time created a complete cycle of operations in the Leblanc process, so that no useless residue is left. Everything is now converted into saleable products or is utilised in some further stage of operations.

The Leblanc process first demands that salt shall be decomposed by sulphuric acid. Now, sulphuric acid cannot be prepared without sulphur, and sulphur was, and still is, a costly substance.

Without entering into the complex chemical reactions, it may be stated at once that all the sulphur in the sulphuric acid ultimately finds its way into this abominable refuse tipped by millions of tons upon the banks of the Mersey, Tyne and Clyde. Innumerable experiments were made to recover the valuable sulphur, but, when tried upon a commercial scale, the processes were either rank failures or too costly to yield any profit. One of the best of these inventions was that devised about 1867 by Dr. Ludwig Mond, to whose philanthropic endeavours to further the progress of chemical research in this country reference has already been made. But Mond's process only succeeded in recovering about half the sulphur from the "waste," so that there was still room for a more efficient system which would extract all the sulphur. Mr. William Gossage, of Widnes, sometimes styled the "father of the alkali trade," devoted a fortune and 30 years of his life to the solution of the problem, and, though unsuccessful, he pointed out in 1861, with wonderful prescience, the lines upon which the ultimate solution would take place. It was reserved for Mr. Alexander M. Chance, of Oldbury, Birmingham, in 1888, to solve the problem which had baffled so many, and his process is now adopted by most of the large alkali makers working the Leblanc system. Mr. Chance makes use in one stage of his system of a kiln invented by Mr. C. F. Claus, of London, so that the sulphur recovery process is usually spoken of by the joint name Chance-Claus.

Limitations of space, and the intrinsic technicalities of the subject preclude any description of this remarkable process, in which air and the waste gases from lime kilns effect the recovery of the precious sulphur.

The industrial use of sulphur is on the increase. It is employed in enormous quantities in the manufacture of gunpowder, washing-blue, vulcanised rubber, in the bleaching of woollen and silk goods, in disinfectants and preservatives, and the wood-pulp paper industry alone consumes about 200,000 tons per annum of this element. The commercial recovery of chlorine and sulphur from "wastes" has not only prolonged the existence of the Leblanc system of alkali manufacture, but has also rendered it highly improbable that this classic process will ever die out. The quantity of soda made by it will, however, be measured by the demand for the by-products, for the soda-ammonia process yields none of these valuable "wastes." To-day it would be almost more correct in the Leblanc works to call soda the by-product in the manufacture of chlorine and sulphur.

CHAPTER IV.

THROUGH DARKEST DAYS.

IN the year 1838 occurred a curious episode in the soda manufacture, which shows that fiscal weapons may often prove to be two-edged. In that year "Bomba," King of Sicily, thought that his miserable revenue would be improved if he granted to a certain pushing French firm a monopoly of the export of sulphur, the chief product of the island. At this time sulphuric acid was exclusively manufactured from brimstone (sulphur) obtained from Sicily. The monopoly was granted, and the price at once was advanced from £5 to £14 per ton, a figure which threatened the existence of the alkali industry, at that time mainly centred in Great Britain. Diplomatic intervention by England ultimately secured the withdrawal of the monopoly, but so far as the alkali industry was concerned it was too late to benefit Sicily; and for more than a generation the sulphur market was entirely disorganised. For it was soon found by chemists that there was a cheaper and inexhaustible supply of sulphur in certain minerals, and they immediately began to

avail themselves of this source for the manufacture of sulphuric acid. When still later the Chance-Claus process, described in the last chapter, showed the way to the recovery of the sulphur lost in the "tank-waste," the plight of the Sicilian industry became worse. Wages were reduced to starvation rates, ruin and revolution appeared to be impending, and the Italian Government was petitioned to assist the island by removing the then existing export tax of about 8s. per ton.

When at first the metalliferous sulphides began to be substituted for pure sulphur, the ore from our own Cornish mines was used, and also that from certain deposits near Wicklow in Ireland. But of recent years the main supply of "pyrites" has come from Spain, where abundant deposits of ore are found containing a high percentage of sulphur combined with copper, iron, and arsenic, together with minute quantities of silver and gold. By roasting the pyrites, the greater proportion of the sulphur is expelled, and the residual cinders were for many years thrown away as worthless, and accumulated in great heaps, being deemed even scarcely good enough for road metal, for which they were sometimes used. Now these unsightly refuse heaps contained whatever small quantity of copper had been present in the original ore. In some instances the pyrites had not contained more than one per cent. of this metal, and it was not thought worthy of extraction. But the idea of the latent wealth in these tip-heaps disturbed the minds of many chemists, and in

1850 the late Mr. Wm. Gossage purchased some of these accumulations of so-called rubbish, and erected works at Widnes, for the extraction of the copper by smelting processes.

But when Spanish pyrites began to be used this mode of working was superseded by a brilliant process carried out by yet another British inventor, Mr. William Henderson, of Glasgow, who in 1859 took out a patent for a method of converting the copper in the "waste" to copper chloride by grinding the pyrites cinders to powder, mixing them with a small proportion of salt, and then roasting the mixture in a current of air. The copper chloride thus formed is easily dissolved out by water, carrying with it in a soluble form all the silver and gold. By a simple process devised by Mr. Frederic Claudet, of London, the silver and gold can be easily and cheaply extracted from solution by means of iodide of potassium. The final residue, after the extraction of the more valuable metals, is a purplish powder consisting of practically pure iron-oxide. In the works of THE UNITED ALKALI COMPANY some 150,000 tons per annum are produced of this residue, which, either in the form of "purple ore," or pressed into briquettes and baked to render the blocks coherent, finds a ready and profitable sale amongst the blast furnace proprietors, for conversion into pig iron. Thus once more is waste turned to wealth, and the Leblanc soda industry again reinforced by the great value of the residuals occurring in the manufacture of sulphuric acid from cuprous pyrites.

Pyrites Burners.

It was stated above that the pyrites contained a certain amount of arsenic. Now arsenic is a very volatile body, and at a moderate temperature is turned into vapour. This deadly poison has, however, certain valuable properties to the chemist, which give it a considerable commercial value. In the manufacture of glass and glazes it has a distinct use, and hence commands a good price in the market. A profitable future awaits the discovery of a cheap and easy process for capturing the arsenic at the moment when it is vaporised during the roasting of the pyrites. Many highly ingenious methods have been devised in the Central Laboratory of THE UNITED ALKALI COMPANY, at Widnes, but like many brilliant laboratory devices, these methods have only in part fulfilled the hopes of their inventors when applied on the large commercial scale. At the moment of writing a method is being tried which promises complete success. There are still technical difficulties to overcome, but that these will be ultimately conquered cannot be doubted. These experiments, carried on at great cost, involving the services of a staff of trained chemists (of whose work more remains to be said), afford an instance of the determination of this great Company to maintain the supremacy of this country in an industry which is of national importance.

The process of soda manufacture originally devised by the genius of the Frenchman Leblanc, has been so developed that modern works would be absolutely unrecognisable by the original

inventor. Although to-day the manufacture of alkali by this process is still practised in Germany and in America, the apparatus, methods, and inventions of the great pioneers who created the alkali industry in Great Britain have been adopted elsewhere without modification.

In the manufacture of the "heavy chemicals" this nation has for nearly a century been pre-eminent, and it is the intention of the Directors of THE UNITED ALKALI COMPANY to maintain that supremacy as far as British brains and skill can secure it. In this endeavour every patriot will wish them success, for the loss of a trade employing millions of capital and thousands of men, and the decay of a staple industry which, as was seen in the first chapter, is the mother of a thousand other industries, could not be viewed with equanimity.

About 40 years ago a cloud began to appear upon the horizon, which for many years over-shadowed the prosperity of the Leblanc industry. It had long been known that if "bicarbonate of ammonia" is added to a strong mixture of salt and water, what is known in chemistry as a double decomposition occurs, and "bicarbonate of soda" is formed, which settles down as a precipitate. This is a much shorter cut to the production of the carbonates of soda (soda-ash and soda-crystals) than that found by Leblanc. But, as described in the second chapter, the chemical engineering of the time was not equal to the problem of conducting this process upon a profitable commercial scale, until Ernest Solvay, a young Belgian

inventor, overcame the engineering difficulties and started manufacturing alkali by the ammonia process at Couillet, near Brussels. Leblanc invented a *process*, Solvay an *apparatus*.

The economic revolution effected by Solvay's invention was stupendous. No Leblanc manufacturer could produce soda ash so cheaply, and when, in the "seventies," Messrs. Brunner, Mond and Co. established works at Northwich to manufacture alkali by Solvay's process, an era of disastrous competition set in which threatened to destroy the Leblanc industry. Indeed, if the manufacturing exponents of the latter had been confined to the production of soda, they would before now have been driven from the field. The by-products utilised, as already described, for the manufacture of bleaching powder, chlorate of potash (used enormously for making safety matches, percussion caps, explosives, &c.), chlorate of soda (used in the dyeing industry), and many other chlorine products have been their salvation. But it can readily be credited that an industry into which such a bombshell as the "Solvay" process was thrown was bound for some years to be perturbed and disorganised, and open to attack upon all sides. No longer able to place upon the market their main product at a price which carried a profit, it became necessary to develop the economic production of the residuals which the "Solvay" process does not yield. For a while it seemed as though the vast machinery employed in the Leblanc process would be no

better than so much scrap iron, for the new process forged ahead with startling rapidity. The very existence of the industry itself, in which many millions of capital had been embarked, depended hereafter upon the output and price of the products recovered from the "wastes."

To enable the reader to realise the situation, one might for a moment picture in imagination the position of the gas industry if an extremely cheap and easy method of manufacturing electricity were suddenly discovered. In order to avoid utter extinction through internecine competition, to regulate the selling prices of the Leblanc products, to establish friendly arrangements with the "Solvay" manufacturers, and to present a united front in dealing with the growing foreign tariffs, it was essential that some amalgamation of the Leblanc Soda Works should be formed. There was, and always would be, a demand for chlorine and other products, and the formation of a combination would enable all patent processes to be used without restriction throughout the amalgamated firms. It would further concentrate all the scientific research work in one central institution, and secure a unity in management capable of effecting economies and enforcing a general standard of efficiency. The same standard of purity of the chemical products throughout the numerous factories could alone be secured by incorporating the Leblanc works under one common directorate. Additional advantages would also result in the reduction of cost of transit by

supplying goods from the works nearest the consumer. With these ends in view THE UNITED ALKALI COMPANY was founded in 1890 by the amalgamation of 44 of the principal alkali firms in the United Kingdom. Since that date other firms have also been incorporated. The Company consequently possesses the plant and processes, whether patented or otherwise, of nearly all the principal well-known brands of alkali and its allied products. It has retained in its service all the principal managers and technical experts who were attached to the respective works, so that continuity of manufacture was assured. The organisation is now so arranged that the manufacture at each works is subject to central comparison and control, which has naturally resulted in the best methods being adopted in all the works, and in a levelling up of the quality of their respective products. The total share and debenture capital of the Company is at present between eight and nine millions sterling.

A large staff of scientific men are continually at work in THE UNITED ALKALI COMPANY'S Central Laboratory, at Widnes, near Liverpool, investigating new methods and improvements in old processes. This work, which has been of enormous value to the Company, combined with the works organisation, to which reference has been made, has resulted in placing the Company in the position of being able to manufacture its combined products as cheaply as, and probably more cheaply than, any other manufacturing concern in

the world. Notwithstanding this the struggle of THE UNITED ALKALI COMPANY has been severe. The long continued trade depression following shortly upon its incorporation, together with the frequent strikes in the coal trade and consequent rise in the price of the raw materials, and the steady growth of hostile tariffs, struck severely at the prosperity of the newly-founded organisation. Then, too, the Company was dependent upon the proprietors of salt beds and copper mines for the supply of salt and pyrites, the very thews and sinews of the industry.

How THE UNITED ALKALI COMPANY has gradually triumphed over all these adverse circumstances, until now in possession of its own inexhaustible salt deposits and its own pyrites mines, it occupies a position of exceptional independence, with brighter prospects before it of prosperous achievement than at any moment of its previous history, must be told in another chapter.

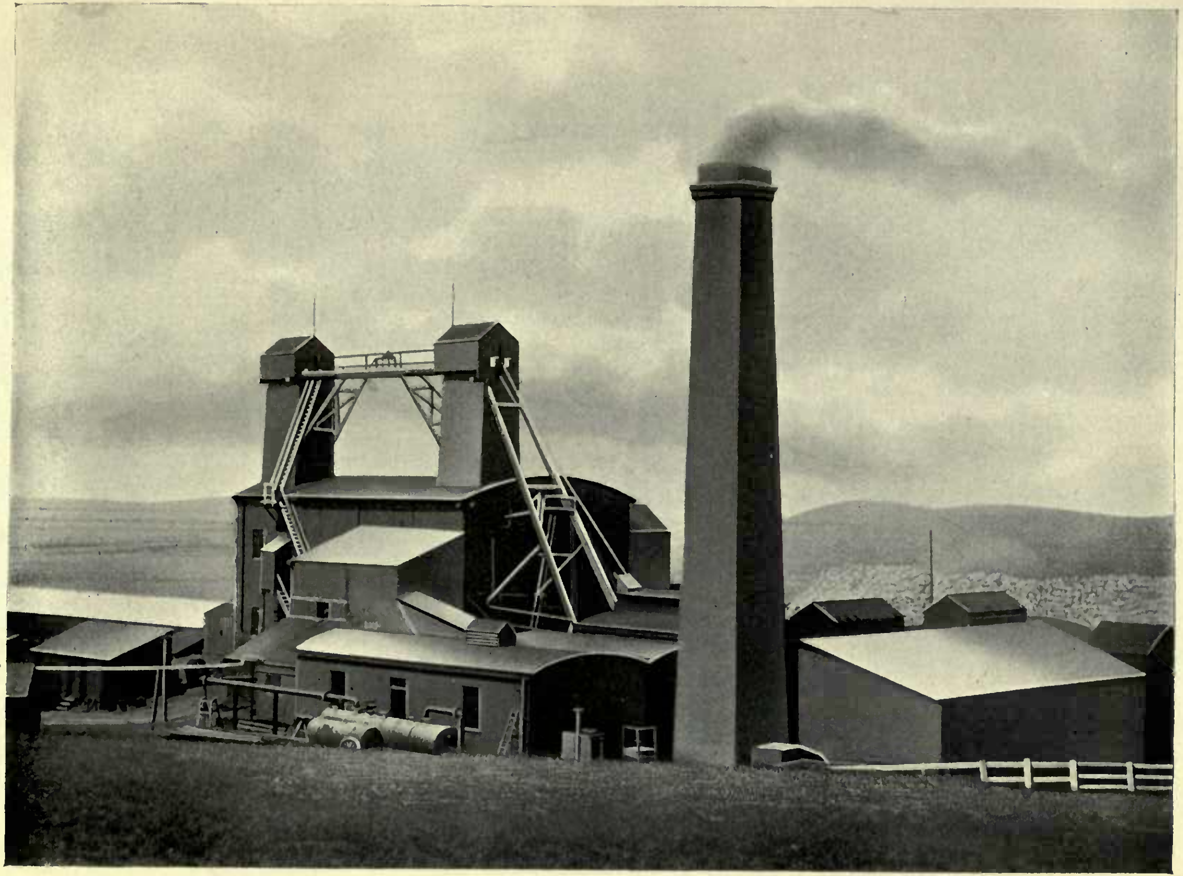
Chapter V.

FORTIFYING THE POSITION.

THE Leblanc alkali trade may be likened to a ponderous building resting upon four massive piers, each pier being absolutely essential to the support of the superstructure. The piers may further be represented as hewn out of the four minerals which constitute the raw materials of the alkali manufacture—coal, limestone, salt and pyrites. A "corner" in any one of these four great staples of the industry, or sudden fluctuations in their market price, would be capable of disorganising the whole alkali trade, by raising the cost of production so as to leave no margin of profit. One of the earliest and heaviest tasks of the amalgamated companies, lay in the inauguration of a policy whereby The United Alkali Company should be raised to a position of independence, and protected against the variations of fortune to which those dependent upon others are, and ever must be, open. In other words, the Directorate felt the imperative need of owning their own salt and pyrites, the two mainstays of the industry most subject to fluctuations in price. Coal and limestone do not present the same problem. Though the latter materials rise and fall in value,

largely in sympathy with the price of labour, there is no possibility of any monopoly in them being established. Coal and limestone (or chalk) are, moreover, found in such extraordinary abundance in Great Britain, that a contemplation of any shortage in the supply of these prime necessities is outside the range of practical politics. THE UNITED ALKALI COMPANY can draw upon innumerable sources for the supply of these commodities. But the case is quite otherwise in respect to salt and pyrites. They are neither so abundant nor so widely disseminated. A monopoly of the output of these materials is conceivable.

The salt lands in Great Britain, until quite recently, were supposed to lie almost entirely in Cheshire, Staffordshire and Worcestershire. But in 1862, whilst boring for water near Middlesbrough, an extensive deposit of rock salt was discovered. Incidentally, petroleum was also tapped, but not in paying quantities. Again, in the "seventies," at Preesall, near Fleetwood, when in search of hematite iron ore, a very valuable bed of rock salt, some 300ft.-500ft. thick, was penetrated at a depth of 400 feet from the surface. Though the existence of this salt bed had been proved, as above stated, it was not until 1889 that, through the untiring energy and foresight of the late Mr. Joseph Wethered, this immense and virgin salt field was explored and developed. In association with Mr. F. H. Gossage, of Liverpool, and Mr. Charles Thomas, of Bristol, the undertaking



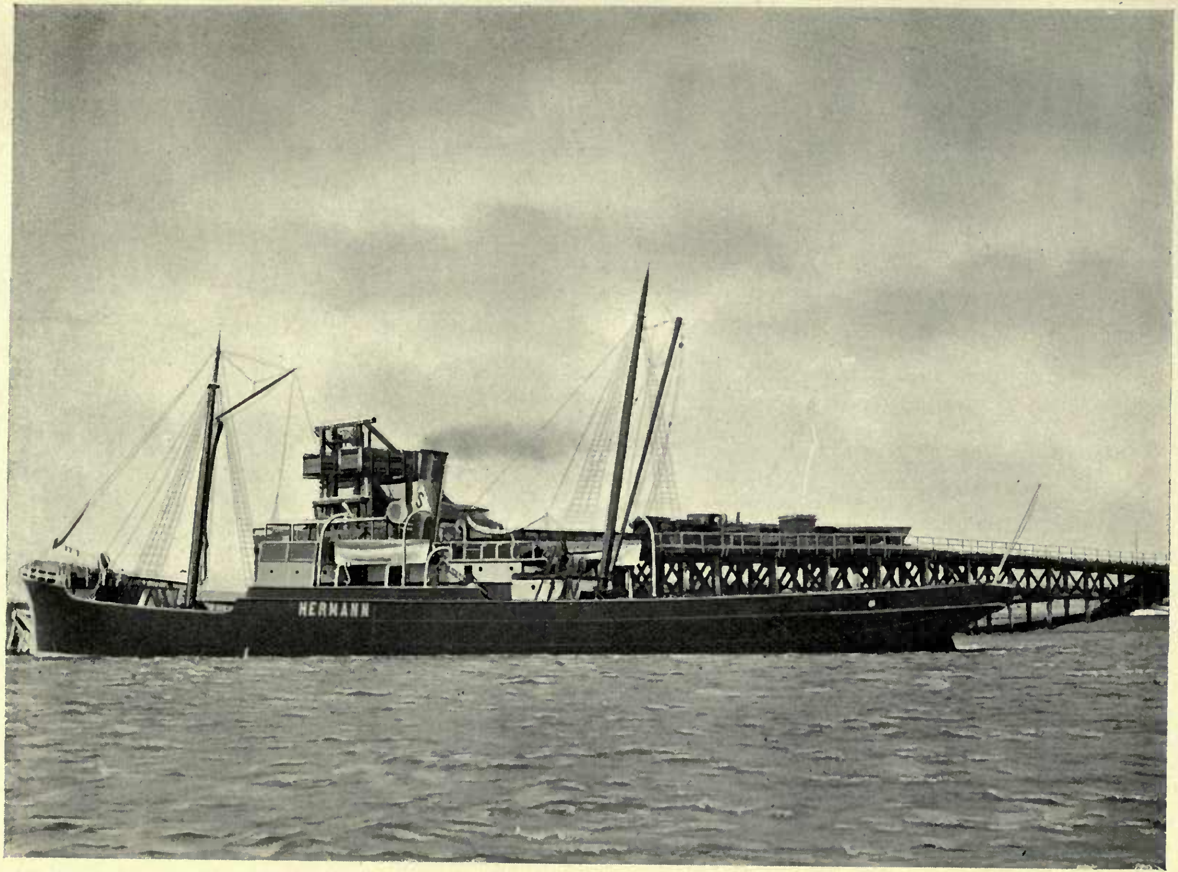
Rock Salt Mine, Preesall.—Pit Head.

known as the Fleetwood Salt Company Limited was established, being subsequently acquired by THE UNITED ALKALI COMPANY in 1890. In 1892 THE UNITED ALKALI COMPANY built at Fleetwood magnificent works on the most modern lines for the manufacture of alkali by the Solvay process (to which system frequent reference has already been made), and at the present moment many thousands of tons of soda ash are turned out annually from this factory alone.

Briefly put, the whole of this process as conducted at the Fleetwood works consists, as stated in the last chapter, in saturating brine with ammonia gas, and afterwards with carbonic acid gas. Bi-carbonate of soda is precipitated as a sediment and is filtered out. The bi-carbonate is then converted into soda ash by strongly heating it in a "muffle" furnace. The ammonia gas is obtained from the by-products of the power-gas plant, and the carbonic acid gas from lime kilns. It is a simple process, but one involving many mechanical difficulties. In 1894, the Company opened out a mine at Preesall, and are now raising some 4,000 tons per week of salt. A descent into the Preesall pit is an experience of unusual interest. Though the mining operations have only been conducted for a dozen years, the weird lofty cavernous vaults formed by the excavation of over a million tons of salt are sufficiently impressive, when illuminated as they are by electricity, to bewilder the spectator who visits them for the first time. The rock salt is so

dense and tough that it is necessary to win it by blasting. It is discharged directly from the mouth of the mine into railway trucks beneath, and is then run down to Preesall jetty, where vessels and steamers up to 1,600 tons, exempt from all dock dues, can be loaded with great rapidity. With such enormous supplies of salt at command THE UNITED ALKALI COMPANY can not only supply all its own wants, but has also become the second largest white salt manufacturer in Great Britain, having put down extensive evaporating works both at Fleetwood and Middlesbrough.

The Fleetwood Rock Salt has established for itself a very high reputation both in the Australian and South American markets, especially for cattle purposes. For these two particular markets the Rock is not only loaded direct from the Fleetwood docks, but is also shipped from Liverpool and elsewhere. Agriculturists know the value of salt in "sweetening" old pastures, and consequently the Fleetwood "Fine Screened Rock" is in great demand amongst agricultural communities. Large quantities are sent every year to Denmark, Holland, and Belgium, in addition to the home consumption. At the port of Fleetwood, vessels up to 5,000 tons burden can enter the docks, which offer every facility for quick despatch of tonnage. Vessels loading salt at the Company's Burn Naze Jetty are also exempt from dock dues, and the trimming of cargoes in bulk is undertaken by the Company at a merely nominal charge. The essential feature of the Fleetwood Salt



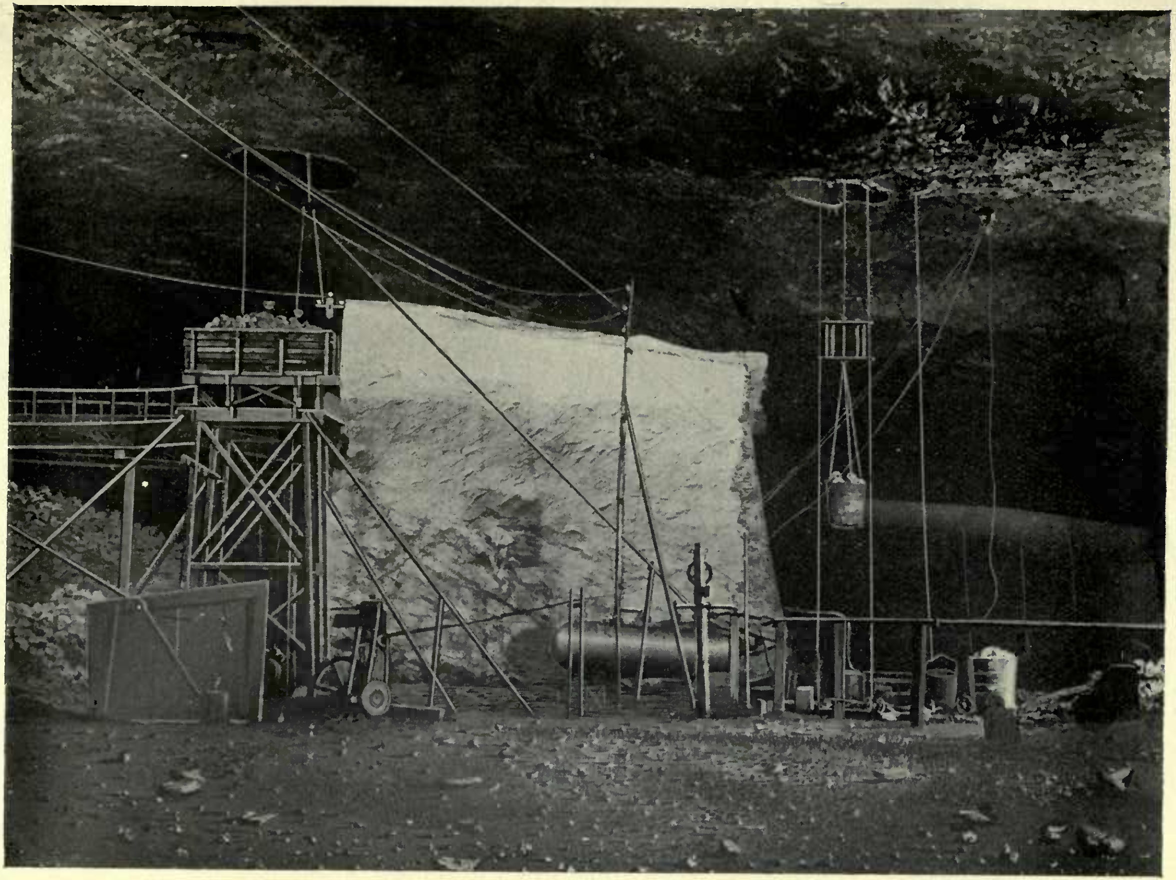
Rock Salt Jetty, Fleetwood.

obtained by evaporating the brine, is its brilliant colour and its flocculent nature, which have obtained for it a recognised character in the home and export markets. The various qualities of table salt are prepared by the latest milling processes. Perfect cleanliness is enforced in the manufacture, rendering it particularly suited for domestic purposes. "Common" salt is largely exported to the Baltic, Canadian, and Continental markets during the season. In India and Burmah "Fleetwood Butter Salt" has also won a high appreciation, owing to its brightness, whiteness, and lightness. For fish curing purposes Fleetwood Salt is largely shipped, among other markets, to the Faroe and Iceland fisheries.

To render its position still further secure, and even impregnable, in the matter of its salt supply, the Company has also acquired, some seven or eight years ago, the Wimboldsley estate, near Winsford in Cheshire, consisting of 1,000 acres of the very best salt land in the county. At present this source is untapped, and is being kept as a reserve in case of need. The Company is also the proprietor of large salt works at Middlesbrough-on-the-Tees, where the deposits are much further down than at Fleetwood, being from 800 feet to 1,600 feet from the surface. The salt is not mined here, but is obtained in the following manner. A bore-hole is driven, into which a double iron pipe, one within the other, is lowered, and, in the jacket or annulus thus formed, fresh water is let down to form brine. This is pumped up again through

the inner tube. No doubt vast cavities are being formed in the bed of rock salt, but owing to the depth at which it lies, and the thick, strong rock roof over it, no subsidences have taken place as in the Midland districts, nor, indeed, are they likely to take place. The Company now possesses an almost inexhaustible supply of salt (the starting point of the alkali industry), and is, therefore, completely independent of any external control of the salt trade. This is particularly fortunate in view of recent movements, which have been made in certain directions, to restrict the output of this mineral.

Of the four great pillars upon which the complex structure of the alkali trade rests, the last, but not least, to be considered is the raw material known as "pyrites." The same policy which dictated the acquisition by the Company of its own "salt lands," has led also to the purchase of extensive deposits of copper pyrites. The chief supplies of pyrites suitable for the purposes of the alkali trade are drawn from the vast deposits in Spain. Within the last two years THE UNITED ALKALI COMPANY has acquired large properties in the province of Huelva, in close proximity to the famous Tharsis and Rio Tinto Mines. Within the present year some 75,000 tons of these pyrites, from the Company's own properties, were shipped direct from Huelva to Garston (above Liverpool), within easy reach of the great centres of the chemical industry at Widnes, Runcorn and St. Helens. This figure can be largely exceeded in



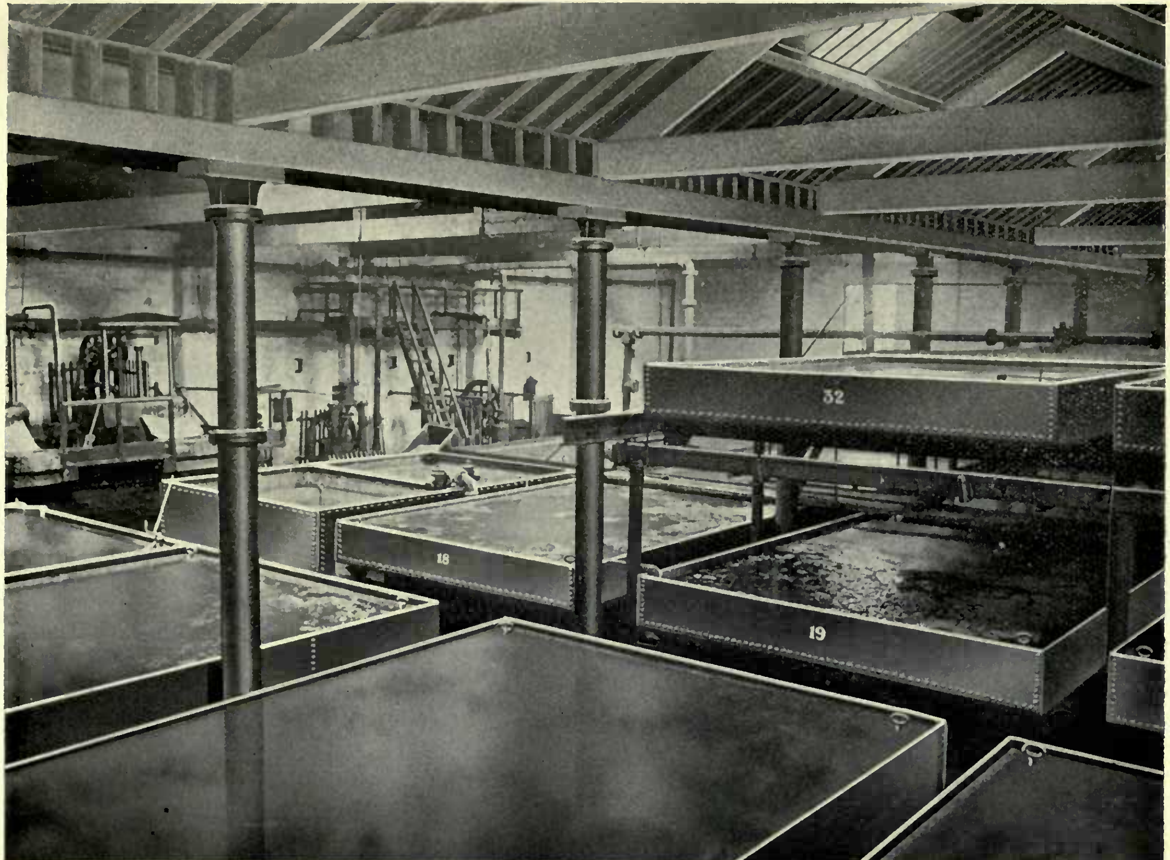
Interior Rock Salt Mine, shewing Bucket ascending.

the future. The possession of its own pyrites deposits cannot fail to have a profound influence upon the future prosperity of the Company. Instead of being in the hands of the mine owners, whose prices for ore were constantly fluctuating, it is now itself in the position of a proprietor, and is, therefore, independent of outside control. The position is curiously anomalous. The mineral is required in the first place for the sulphur that it contains. The copper, as described in the last chapter, is merely a residue, found in the ashes or cinders after the sulphur has been roasted out. But in this instance the "tail wags the dog," for copper is in such great demand that these cinders practically regulated the price of the original ore. Hitherto, therefore, the Company has found the cost of its pyrites rising and falling in sympathy with the copper market. For the future, however, as owners of immense deposits of cupriferous ore, the Company can naturally take advantage of any advance in the market value of the metal. The ore which is now being quarried from the Spanish mines of THE UNITED ALKALI COMPANY is rich in sulphur, containing nearly 50 per cent. of this element. The residual cinders contain iron, copper, silver, and a small, but appreciable, quantity of gold. The above metals are extracted by the Henderson process, described in the last chapter, and contribute no inconsiderable share to the profitable operations of the Company.

The forementioned acquisitions have not by any means exhausted the activities of the

Directors in still further fortifying and intrenching their position so as to meet foreign competition. Friendly relations, as already stated, have been established with the great firms which produce soda products by the "Solvay" process. The home and colonial market has been extended by the manufacture of cyanide, fertilisers, soap, acetic acid, acetone (for cordite purposes), disinfectants, and by many chlorine products, besides bleaching powder and chlorates, such as chloroform, sal-ammoniac, chlorobenzene, &c. In conjunction with a Norwegian firm, the manufacture of carbide of calcium (used for the production of acetylene gas) has been established in that country, where water-power is to be had very cheaply. Similarly, though in this case for tariff reasons, about six years ago large interests were acquired in certain concerns in America for manufacturing the chlorates of potash and soda by electrolytic processes. When it is realised that up till 1894 these chlorates were admitted free into the United States, whereas now there is a duty upon them of nearly £12 per ton, the necessity for the acquisition of these interests will be apparent. The American chemical manufacturer is protected by high tariffs, and on that portion of his production which is consumed in his own country the profits are exceedingly high. The same is true of the German producer.

The vicissitudes of THE UNITED ALKALI COMPANY, as told in this and the preceding chapters, have been the experience of many great



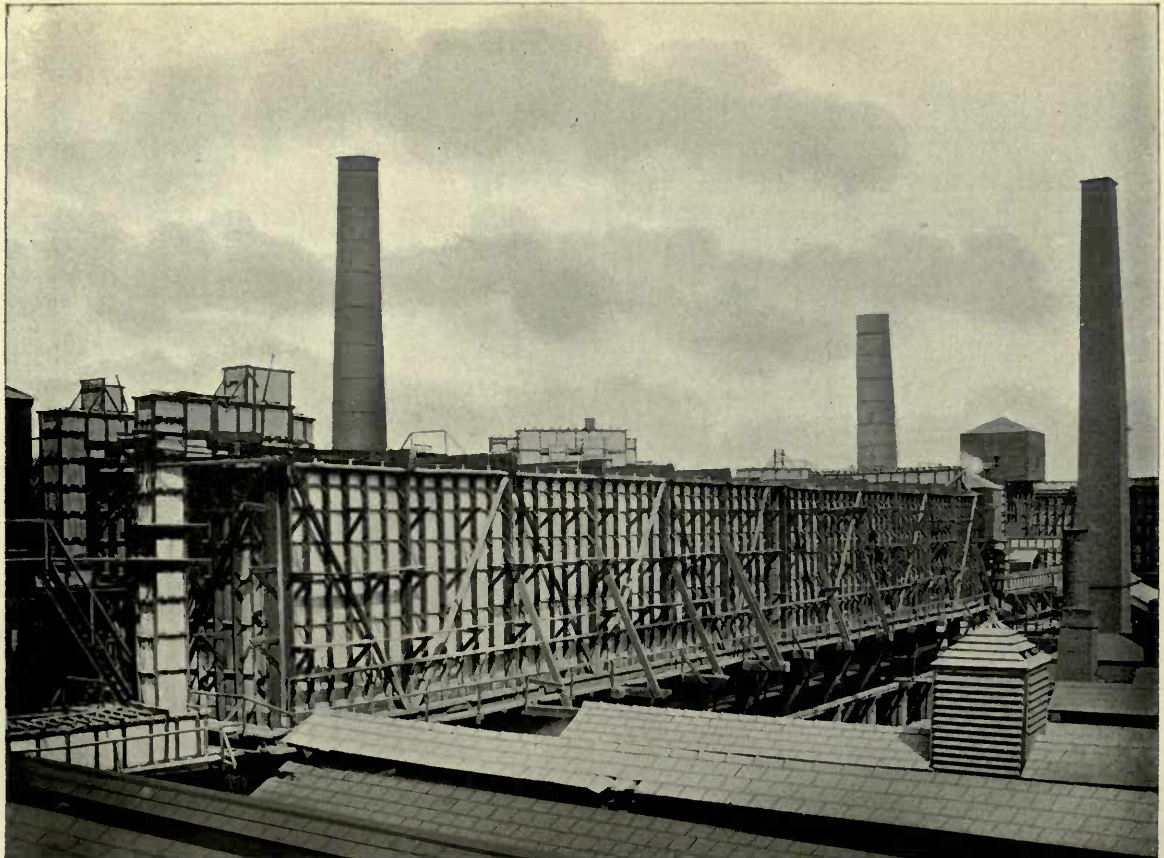
Chlorate of Potash Crystallising House.

industrial concerns in this country. Not all of them have survived the dark days of the last two decades, during which hostile foreign tariffs, one after the other, have destroyed the greater portion of their over-sea trade. The foregoing pages have endeavoured to show how, though sorely stricken, this great Company has survived the "slings and arrows of outrageous fortune." Founded and conducted in no aggressive spirit, but simply upon the principal that unity is strength—by securing for itself an unlimited supply of the raw materials of its industry, by gradually consolidating its resources, and by meeting competition with brains—the Company has at length arrived at that point where it is able, not merely to hold its own, but even to challenge the position of those rivals in the strife who fight behind the sheltering barriers of protective tariffs. The maintenance of the supremacy in the industrial battle with foreign manufacturers is no easy matter. Certain other factors that make for, or against, success will be discussed in the next chapters.

Chapter VI.

THE FARM, THE MINE, THE HOSPITAL AND ALKALI.

THE readers of the preceding chapters will have already gathered that the term "alkali" in its commercial sense has a somewhat extensive signification. Originally meaning nothing more than the carbonates of soda or potash, it now includes a vast number of subsidiary and auxiliary manufactures which could not under any modern scientific nomenclature be classed as "alkalies." In strict chemistry an alkali is the antithesis of an acid. The United Alkali Company, however, belies its title, in that it is the largest manufacturer in the world of sulphuric acid (vitriol). It will be remembered that the first stage of the classic Leblanc process for preparing soda ash requires that common salt shall be decomposed by sulphuric acid. Hence the alkali manufacturer is generally also a producer of vast quantities of "oil of vitriol," to give it the old-fashioned name. Inasmuch as this acid is in great demand in numerous other industries, the Company, after supplying the needs of its own works, places upon the market all

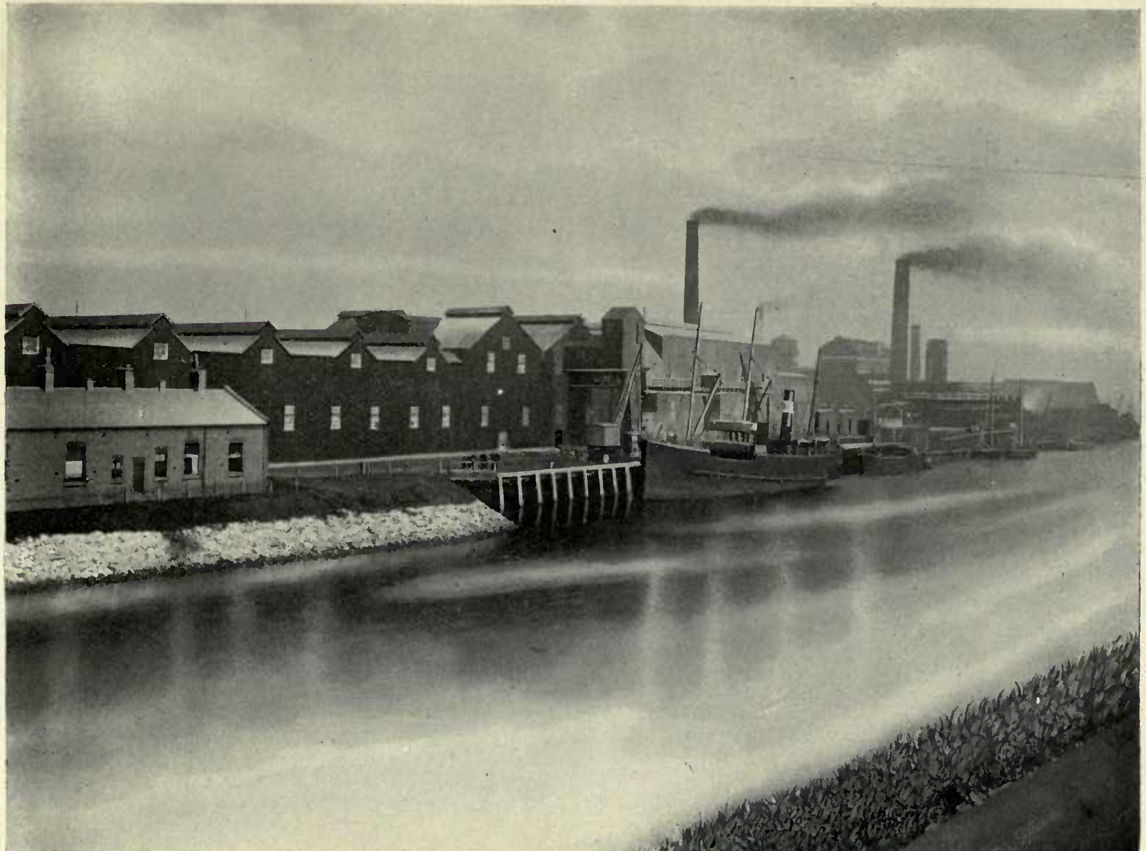


Sulphuric Acid Chambers, Gaskell Deacon Works.

grades of sulphuric acid, at prices, it may be added, with which others find it hard to compete. In thus supplying the great demand for sulphuric acid they are aided materially by their ownership of the pyrites mines near Huelva, as described in the last chapter. The practically illimitable resources of sulphur contained in these deposits of ore would alone place THE UNITED ALKALI COMPANY in a position of exceptional strength in the manufacture of vitriol; but when it is also recollected that the residual cinders after the sulphur and arsenic have been roasted out are rich in iron, copper, and silver, and contain also a small but regular proportion of gold, it will be readily conceded that the Company has solid reasons for believing itself able to maintain the lead in the manufacture of this highly important chemical product. One of the chief uses of sulphuric acid is in the preparation of artificial fertilisers. Certain substances such as bones and the mineral known as "phosphate rock" contain a quantity of phosphates in an extremely insoluble condition. To convert these materials into a state in which the valuable phosphoric acid is present in a more soluble form it is necessary to break up the chemical constitution of the bones or "rock" by means of sulphuric acid. The resultant products are respectively known as "dissolved bones" and "superphosphate," familiar to agriculturists as the most valuable of all fertilisers for the growth of cereals and roots, and also for developing the clovers and richer grasses on pasture land.

Agriculture tends more and more to become a branch of the science of chemistry. The soil of all old countries is to some extent exhausted, and the artificial restoration of those elements of which it is robbed by constant cropping is rendered imperative if the farmer hopes for a profitable yield in return for his labour. Two substances in particular which must be present for the successful growth of food-stuffs are phosphoric acid and nitrogen. A soil deficient in these constituents cannot possibly produce a satisfactory crop, however careful may have been the tilling, and however good the seed. Moreover, a soil once deprived of its phosphates and nitrogen does not readily regain them. The processes of Nature are slow, and years must elapse before the lost elements are once more restored through natural agencies. To the modern farmer cheap fertilisers are therefore as essential as cheap labour, transport, or machinery. THE UNITED ALKALI COMPANY is one of the agriculturist's most trusted friends. Since it started this branch of business its sales have continued steadily to increase, until it is now the largest manufacturer of chemical fertilisers in the United Kingdom.

Though the Company handles every kind of artificial fertiliser, it has made a speciality of superphosphates, which, used in conjunction with farmyard manure, supply the plant food required by all crops. The Company has lately built, on the Manchester Ship Canal at Runcorn, a great fertiliser manufactory, where steamers of large



"Wigg" Works, on the Ship Canal, looking East.

tonnage can berth alongside and discharge or load directly into or from the works. At the moment of the visit by the present writer, a large Spanish vessel of some 5,000 tons burden, from a port in Florida, was unloading a cargo of "phosphate rock" within ten yards of the machinery which would presently reduce the rock to powder, before mixing it with the dissolving acid. In this great factory everthing is designed to save labour. As the cargoes of phosphates, bones and other raw materials come up the canal, they can be discharged by an elevator, day or night, on to a high stage, which thus places them on the desired level. Very little manual labour is then bestowed upon them until they reach the final operation of being stowed in the form of finished products in the hold of some ocean-going or coasting vessel. A quantity approaching 100,000 tons of superphosphate is at present turned out annually from the works of the Company, much of which is exported to our colonies and foreign countries, where its value is appreciated quite as well as amongst British agriculturists. The power for this extensive factory is supplied by a 600-h.p. Corliss engine, generating the power for driving the whole of the machinery electrically, and for lighting the premises. The Company employs a staff of highly-trained scientific experts, who are also practically acquainted with agricultural subjects. Special combinations of fertilisers are manufactured for the culture of the vine, tea, sugar, tobacco, cotton, beetroot, rice, &c., each mixture being devised to meet the

particular needs of the plant. Advice is given freely to inquirers as to the best and most appropriate fertilisers for any particular kind of crop and soil, as well as the most suitable method and time for applying them. Indeed, the Company invites correspondence upon these matters, and the expert knowledge of the staff is always open to customers and other enquirers. The Company issues a handy and very practical little pamphlet descriptive of the various fertilisers. This booklet also gives the analytical composition of each (all the analyses being guaranteed by eminent agricultural chemists named in the pamphlet), and also contains instructions as to the soils and crops for which each individual fertiliser is particularly suited. One of the points upon which the Company prides itself, is that its special process of manufacture turns out the fertilisers in a thoroughly dry and friable condition. This is a matter of great importance to the consumer, especially to those who use the drill. The great storage power of the Company enables it to manufacture large stocks during the autumn, and to hold them in first-class condition, ready at any time for immediate delivery. The fertilisers are put up in quantities to suit the purchaser, and, in this connection, it may be remarked that the Company deals directly with, and studies the requirements of, the small consumer of its products with the same care as it provides for the necessities of those who buy in large bulks. Not only are fertilisers purchasable in small quantities, but

such materials as bleaching powder, soda ash or crystals, caustic soda, pearl ash (carbonate of potash), &c., may be had for household use in air-tight tins containing 1-lb. and upwards.

From the farm to the mine is, perhaps, a far cry; but they meet on common ground under the roof of a chemical works. The sulphuric acid that prepares the fertiliser for the farm, aids also in the manufacture of blasting agents for the mine. Cordite, nitro-glycerine, gun cotton and blasting gelatine all owe something in their preliminary stages to the powerful action of vitriol.

But the most interesting development in the application of chemistry to the mining industry is, perhaps, in the use of "cyanide" for the elimination of the last traces of gold from "slimes" and "tailings" after the pulverised ore has been subjected to the ordinary mercurial treatment for extracting the gold. Previous to the existence of this modern demand, "cyanide" was employed to a small extent in electroplating, and as a laboratory reagent of occasional service. In 1887 Messrs. MacArthur and Forrest took out a patent for extracting gold from the ore by dissolving out the precious metal in weak solutions of potassium cyanide. By reason of its greater cheapness, and on other grounds well appreciated by the chemist, sodium cyanide is now generally used instead of the more costly cyanide of potassium. About 1890 the use of this very remarkable and extremely poisonous body began to come into use upon the Rand. To-day it is in no sense an exaggeration to

say that the prosperity of the vast Transvaal gold industry is mainly dependent upon the discovery that cyanide can be successfully applied to the recovery of gold from its ores. The sudden demand for a substance which had never before been manufactured except on a small laboratory scale stimulated the inventive powers of chemists in all parts of the world. There were difficulties of a very unusual character in solving this problem. "Cyanide" is a compound of soda (or potash) with the most terribly poisonous substance known to commerce, viz., prussic acid, in chemical nomenclature always styled hydrocyanic acid. This acid is a gaseous body having a smell of bitter almonds (as a matter of fact it is present in very minute quantities in bitter almonds and in peach kernels), and is so excessively dangerous that inhaling a breath of the *pure* gas is sufficient to cause instant death. When dissolved in water, liquid prussic acid is obtained (the merciful executioner of many a favourite dog), and in this form it is sold under rigid restrictions to pharmacists. A graphic illustration of the intensity of the action of prussic acid has been given by a well-known chemist, who has said that if in a theatre a bomb containing this gas were exploded, only those who were nearest the doors could possibly escape the fatal effect of the dread fumes. It will be understood, therefore, that the invention of any process that would deal safely on a manufacturing scale with this invisible but death-dealing agent would be a chemical and engineering triumph of the first

Cyanide Works immediately after the Fire.

order. Space does not allow of a description of the tremendous difficulties to be overcome, and the manner in which the able staff of chemists, and the managers of the works of THE UNITED ALKALI COMPANY at the Central Laboratory at Widnes, worked out a process which finally conquered all obstacles. It is one of those romances of science which deserves a fitting record. The "Raschen" process, as it is called after its inventor, is now in full operation at the works at Runcorn, and some thousand tons of sodium cyanide are there being turned out annually.

As a further illustration of brainy enterprise it may be stated that the cyanide plant, which occupies a lofty three-storey building filled with much costly machinery and apparatus unique in its character, was burned to the ground on the 24th of May, 1901. The reconstruction of the building and of the plant (all of which had to be specially designed) was considered by outside experts to be a work that would occupy at least twelve months. The managers and officials of the company thought otherwise, and bringing to bear upon the problem their united experience, energies and mechanical resources, they resolved themselves to direct the work of restoration. On the 30th of September, 1901, practically four months after the fire, these works were re-opened, and the interrupted manufacture of cyanide was again resumed. The rebuilding and equipment of so great a structure in so short a space of time

cannot be bettered, even if it can be equalled, by the rapid methods always associated with American enterprise.

The science and practice of medicine owe much to chemistry, and not least to the evolution by the chemist of those compounds (disinfectants) which have for their end the destruction of bacterial life. It is not easy to kill germs. They defy most of the ordinary destructive agencies. A disinfectant should fulfil three main conditions —safety, cheapness and efficiency. The most efficient germicides are mercuric chloride, chlorine and carbolic acid. The first of these is unexcelled in efficiency, but it is too deadly a poison for safety, and it is also very costly. The second is highly efficient, is safe and is cheap. The third, carbolic acid, has a notoriously dangerous character; it is only efficient in strong solutions, and, when this fact is taken into account, it is not cheap. Time after time the most eminent biologists have descanted upon the high efficiency of chlorine as a germ killer. Such authorities as Koch, Klein, Wynter-Blyth, Sheridan-Delépine and Sims-Woodhead have shown that, considered from all aspects, there is no agent equal to chlorine in its disinfecting powers. Its extensive, if not exclusive, use at Glasgow for combating the plague, and at Maidstone and Lincoln during the recent typhoid epidemics, has been so convincing that no health authority can afford to overlook its claims. Since chlorine is a gas, it may be asked how it can be made available as a disinfectant.

Cyanide Works Re-built.

The answer is provided by THE UNITED ALKALI COMPANY in their liquid preparation, "Chloros," containing 10 per cent. by weight of available chlorine. It emits but a slight smell, is completely soluble in fresh or salt water, and not liable, therefore, to block up pipes and drains, as in the case of ordinary solid chloride of lime. It is a complete disinfectant and deodorant for sewage, and is adapted for use in hospitals and private houses. The purposes for which "Chloros" is applicable, vary from the cleansing of cattle pens to the sterilisation of linen. It is a powerful antiseptic, and, in times of emergency, it is sufficiently safe for the treatment of drinking water suspected to contain disease germs. Experimenting in May of this year, upon the particularly refractory *bacillus typhosus*, Prof. Klein found that one part of "Chloros" in 1,500 parts of water destroyed this germ in 2½ minutes, and that its action was thus twenty-one times more powerful than that of absolute phenol (carbolic acid).

The needs of the medical faculty are still further supplied by THE UNITED ALKALI COMPANY. It was seen in an earlier chapter that the Company is the largest manufacturer in the world of chlorine. It is not surprising, therefore, to find that chloroform of the purest quality is one of the recognised products of the works at Widnes. In addition to its well-known use as an anæsthetic, chloroform is an important ingredient in chlorodyne and many other medicines, such as cough mixtures. Chlorobenzene, the starting point of

so many of the synthetic dyestuffs, is another of the chlorine products, in the manufacture of which THE UNITED ALKALI COMPANY has few, if any, compeers. The foregoing chapters can give but an inadequate glimpse of the multitudinous ramifications of an industry which touches life at so many points. The operations of this great organisation of 47 individual manufacturing concerns, whose finished products exceed one million tons annually, which employs some 12,000 men, among whom are about 150 chemists, and which possesses, for its own purposes, a fleet of 82 cargo boats, cannot be described in detail in the course of half-a-dozen chapters. Such a corporation when engaged, as it is, in conserving a great industry ceases to be merely a private enterprise. It is fighting a national battle, and is, therefore, worthy of the widest interest.

Chapter VII.

TO MAINTAIN THE SUPREMACY.

IT has been seen that, wherever salt, limestone, sulphur and fuel can be got together, there alkali may be manufactured. And since the processes and apparatus invented by our countrymen are now common knowledge throughout the civilised world, the only grounds upon which the British manufacturer can base his hopes of retaining the supremacy in this staple industry are that his abundant supplies of the raw materials, and his technical skill, may enable him to place the finished product upon the world's market more cheaply than any one else. Add to this the unparalleled facilities for cheap transport on the banks of the Mersey, the Tyne and the Clyde, and it must be admitted that, "with a fair field and no favour," the maintenance of the supremacy by the British producer would not for a moment be in doubt. But, to pursue the metaphor, the field is not fair, and, as will be shortly shown, there is an undue discrimination in favour of the foreign manufacturer.

When fiscal questions assume such dimensions as to become part of the politics of the day,

individual commercial issues are apt to be obscured. This being so, the following figures may be allowed to speak for themselves, and to illustrate the crushing weight of hostile tariffs upon the export trade of the alkali industry:—

Exports from U.K. to North America under McKinley and Dingley Tariffs.

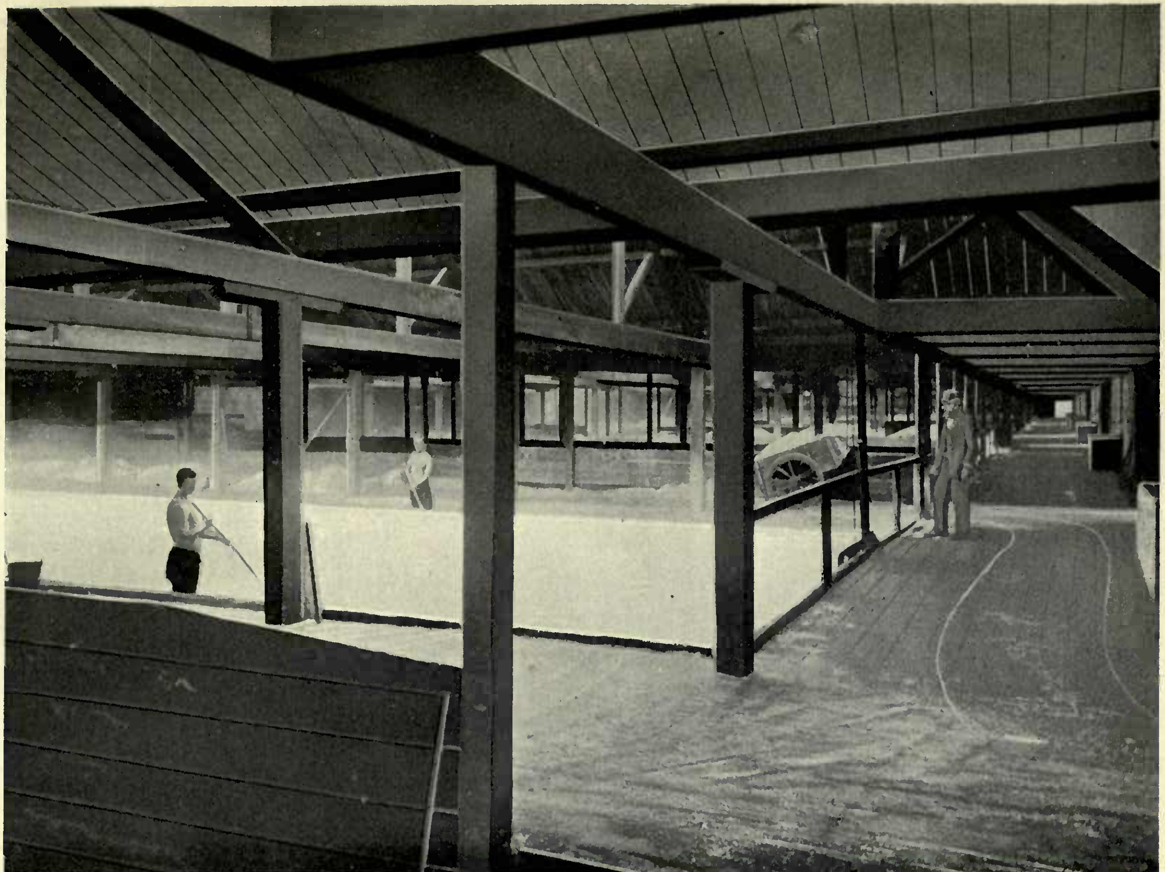
(In Thousands of Tons.)

—	1890		1892	1894	1896		1898	1900	1902	1904
Soda Ash	145	McKinley Tariff	156	135	83	Dingley Tariff	32	34	17	13
Soda Crystals ..	17		15	15	10		4	3	4	3·9
Caustic Soda ..	41		27	25	24		13	7·2	4·2	5·2

The Dingley Tariff, still in force, raised the duty on soda ash to £1 15s. per ton, equal to about 50 per cent. on the f.o.b. value of the article. It also imposed a tax of £11 14s. 4d. per ton on chlorate of potash, about 45 per cent. on its f.o.b. value, which had hitherto been admitted free.

Though space only permits the inclusion of the figures in the above case, similar tables for other countries would show similar and even worse results.

But there are other and serious handicaps upon the British chemical industry, retarding its due expansion—disabilities of native origin, partly social and partly legislative. No industry must be so ready as this to follow freely the light of scientific discovery wherever it leads. The progress of research is constantly evolving ideas which, if put into practice, cause large alterations



INTERIOR OF "COMMON SALT" PAN HOUSE FLEETWOOD.

in the practical methods of business. But research involves preliminary training, and a peculiar habit of mind which is not yet begotten in the great English public schools or colleges. It is not the creature of examinations, nor is it adapted to the competition for scholarships. The great chemical industry owes nothing to the historic educational institutions of this country. If a tithe of the time given in the schools and universities to classical learning had been spent upon scientific studies, this country would have been invulnerable in those industries dependent upon applied science. "The attitude of the older Universities," says Professor A. G. Green, of the University of Leeds, "and of the famous schools towards the scientific student, has deterred many promising and rising young men from adopting chemistry as a profession." Somewhat late in the day, a number of "technical colleges" have been opened, and a hasty but disorganised attempt has been made to catch up to our foreign commercial rivals. These well-intentioned efforts have been but partially successful, and many serious students still think it necessary to visit a German or Swiss "Polytechnicum" in order to pursue the highest forms of research. The splendid laboratory presented by Mr. E. K. Muspratt to Liverpool, and opened on the 13th of October last with much ceremony, will go far to remove this aspersion on British Universities. The Muspratt Laboratory is staffed and equipped for deep research into those problems of physical and electro-chemistry which have such

intimate connection with the future welfare of the chemical industry. "If we continue," says the *Manchester Guardian* in a recent special article upon this subject, "in our efforts for improved education, and remove such industrial hindrances as the present Patent Laws, and the duty on manufacturing alcohol, there is no reason why we should not erect large colour works in this country, and carry them on successfully in spite of the new development in Germany."

A great organisation such as THE UNITED ALKALI COMPANY can do its share, and has indeed done much towards the improvement of scientific education, but it is beyond its scope to revise the Patent Laws, or to frame the Budget in respect to the duty upon alcohol for industrial purposes. Long before local authorities provided facilities for technical instruction, evening classes had been established and supported at Widnes by the great firms now amalgamated under the title of THE UNITED ALKALI COMPANY. To these classes apprentices were sent. Other *employés* were encouraged to attend, by inducements of promotion upon attaining certain standards of proficiency. There are many foremen now holding responsible positions in the various works who owe their advancement to the valuable instruction received in these technical classes. Much is still being done by the Company for the advancement of knowledge. Since the amalgamation in 1890, the highly important work of testing and standardising the chemical products of the constituent

Central Laboratory, Widnes.

firms has been conducted in the great central laboratory at Widnes. Here a staff of very highly-trained chemists is constantly employed, not merely upon the routine work of a works laboratory, but in researches connected with the industry. The startling and brilliant process for the manufacture of cyanide described in the last chapter was worked out in this building, and many other problems which cannot obviously be more closely indicated are at present engaging the activities of the staff. It was a pleasant surprise to the writer to thus find in the somewhat uninviting surroundings of Widnes, a fine three-storey building occupied with ranges of laboratories, workshops, and all the appliances for experimental work upon a commercial scale. Three dynamos, each of 50-h.p., supply the current necessary for the electrolytic researches which are being pursued; and, incidentally, it may be said, that the future developments of the alkali industry appear to lie in this direction. A library is also to be found in the building, rich in technical works and containing all patent specifications relating to alkali manufacture. The work done in this House of Science, though primarily for the benefit of the Company, is in reality of national importance. The impartial observer sees here the intrinsic character of the industrial struggle. It is a battle of *brains*. The quiet unobtrusive directors of those experimental processes are playing with a national industry. A discovery that will shorten by but one step any of the existing methods, may revolutionise a trade,

and bring widespread prosperity in its train. Conversely, under the existing laws a foreign patent may carry ruin and desolation into this district. It is satisfactory to learn that, largely owing to the work done in the central laboratory, many processes have been introduced or so considerably improved that imports of certain products have been checked, and the tide turned into the opposite direction. For sound commercial reasons the actual figures are not here given, but a study of the Trade Returns will reveal these facts to those who are prepared to search the Blue-books and trade journals. The "industrial hindrances," above mentioned in the quotation from the *Manchester Guardian*, viz., the inequitable Patent Laws, and the tax on industrial alcohol, play a disastrous part in the battle. They are handicaps and fetters imposed upon the champion, forged in the house of his friends.

England was the first country to recognise that inventors who introduced or improved an industry benefited the community by causing an increase in trade and employment, and the first also to adopt the method of rewarding inventors by the grant of letters patent, securing to them the exclusive right to their inventions for a limited period. Nearly every civilized nation has followed the example of this country by granting protection for inventions. The foundation of our patent law is the famous Statute of Monopolies of James I., passed in 1623, by which letters patent were granted for the "sole working or making of any

Central Laboratory, Widnes.—Interior of one room.

manner of new manufacture within the Realm to the true and first inventor of such manufacture." Later Acts have done practically nothing but create the machinery whereby this fundamental law is to be carried out. Up to quite lately it was no part of the duty of the Patent Office to inquire particularly into an invention for which a patent was asked. Provided the rules of the office were observed as to the form of the application, and sufficient disclosure made in the specification of the invention claimed, a patent was issued in due course without any opposition from the authorities. The effective force of patents so granted rested on the strength of the opinions which could be obtained from expert counsel, sometimes supported by courts of law.

The risk to capital involved in the purchase of such dubious patent rights, together with a deepening impression that our industries were materially suffering from the monopolies granted to foreigners, who neither worked their patents in this country, nor would allow others to work them, led to the recent act of 1902, which attempts in some measure to remedy these evils. The new Act must, however, be regarded as tentative only. It offers a rough test of the novelty of the invention in the case of new applications, by providing for a search through the files of the British Patent Office for fifty years preceding the application. But the genuine novelty of the invention can only be tested by reference also to foreign patent records. At present the Patent Office gives no

guarantee of the validity of a patent, and the inventor takes the risk of finding that he has paid his fees for protecting a manufacture which is, in fact, open to all the world. It is this lack of certainty which deprives the British patent of the real commercial value of the American or German grants. But from the industrial point of view, more serious than the grant of letters patent, which may not be worth the fees paid on their behalf, is the question of the subsequent working of the patent within the realm. The Patent Act of 1902 does not provide for compulsory working, but only for compulsory *licences*. Therein our law differs from that of Germany or France, in each of which countries the patent may be revoked after the expiration of three years, if the invention is not being worked *by the patentee* in the country from which he has obtained the grant.

There is only one justification for giving a private person an exclusive monopoly, viz., that he may be encouraged to establish a "new manufacture within the realm" (to quote again the ancient Statute above cited). If, therefore, a large number of monopolies is granted to foreigners who are allowed to keep the working of British patents abroad, we are deliberately imposing shackles upon ourselves in the struggle for industrial supremacy. On the 9th of April last, these points were placed very forcibly before the present President of the Board of Trade by an influential deputation from tbe Association of Chambers of Commerce. At that meeting much important matter was brought

forward, showing that the gravest injury was being inflicted, both on employers and employed, by the unreasonable laxity in the Patent Laws.

"The non-working of foreign patents," says Mr. Levinstein (ex-President of the Manchester Chamber of Commerce, past President of the Society of Chemical Industry, and a member of the deputation), "has inflicted incalculable harm "on our trades. There is only one effective "measure with regard to foreign patents, and this "is to make it compulsory to work them on "an adequate manufacturing scale (say) twelve "months from the date the invention is worked "in foreign countries. We grant a far larger "monopoly to foreigners, and on much easier "terms, than other European countries. The "foreign patentee is protected by his high tariffs. "It is, therefore, as a rule not in his own interest "to work in this country the monoply we have so "cheaply given him. He prefers to work it in the "country which gives him high protection, with "the additional advantage of selling to us his "patented article without any restrictions, and at "his own price. This is the converse to dumping. "The foreign patentee rarely manufactures in this "country. The shorter hours and higher wages, "the heavier rates for transport, and the high "duty on industrial alcohol deter him from "manufacturing here. The want of compulsory "working in this country, of monopolies granted to "foreigners, is one of the reasons why, for the last "twenty years, we have established so very few

"new trades or industries in comparison with "other nations. Had we amended our patent laws "in 1877, when patent laws were first established "in Germany, in such a manner as to make them "conform to the latter, a large number of industries "would have been established in this country "which do not exist to-day. The German patent "laws have very largely stimulated enterprise, "and have conferred incalculable advantages "on German trades and industries; ours have "been chiefly instrumental in advancing the in-"dustrial and commercial interests of our foreign "competitors."

Two examples given by the above-named deputation may be quoted here, as they come with all the authority of the Associated Chambers of Commerce:—

"The most important of all dye wares is "artificial alizarin, which has entirely supplanted "the natural madder or Turkey red. It is made "from a raw material (coal tar), of which we "are the largest producers. The process for "making this dye stuff was patented in this "country by a number of foreign patentees, *but no* "*patent was granted in Germany.* Every one was "at liberty to make it and sell it there, whilst "in this country it was a close monopoly. The "German makers realised immense profits which "enabled them to further extend and develop the "manufacture of coal-tar dye stuffs. There is no "doubt that the unrestricted development of the "alizarin industry in Germany laid the foundation

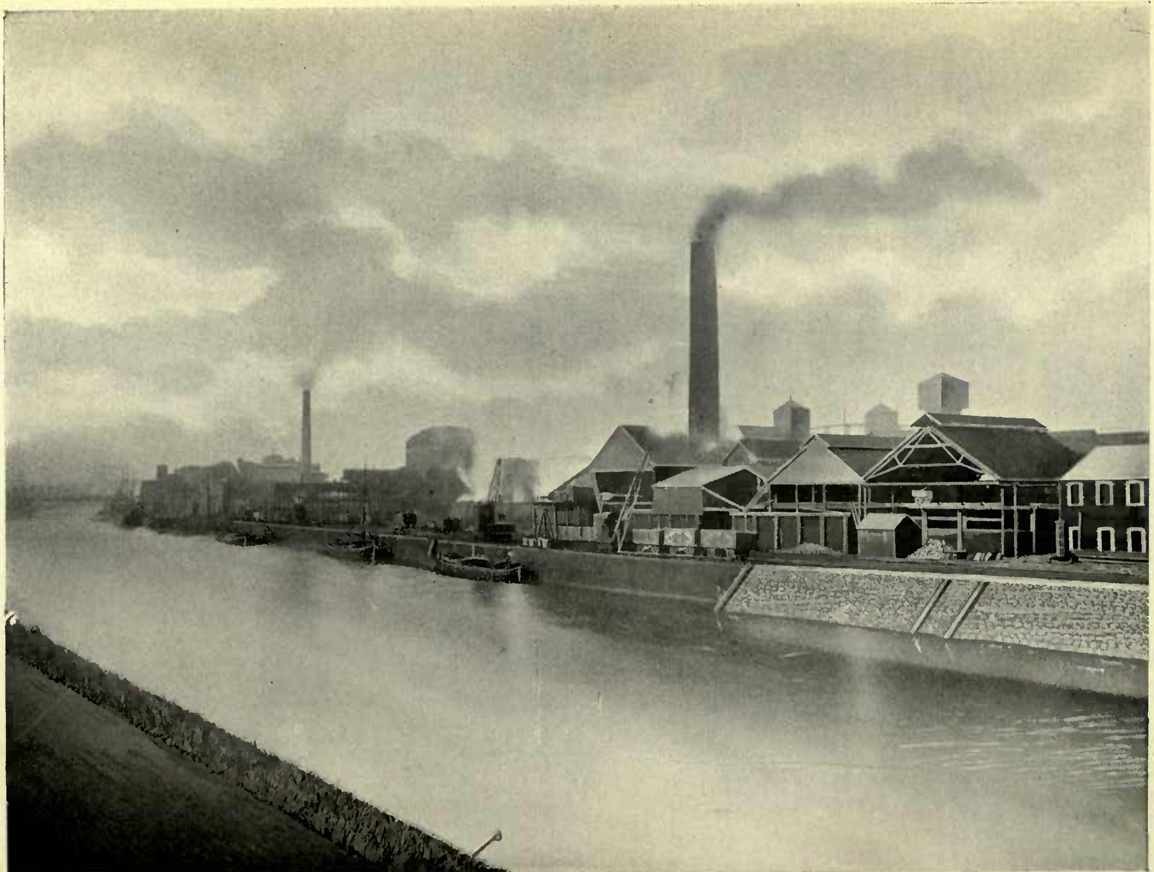
"of Germany's present supremacy in the pro-"duction of dyeing materials. The patents lapsed "more than 24 years ago, and still the Germans "retain a practical monopoly. This is not wholly "due to their superior technical education, but in "the greatest measure is a direct sequel to our "patent laws. Our rivals had a start of fourteen "years in a special industry, not only as regards "manufacturing operations, but also in arrange-"ments for the distribution of their goods in "the various markets of the world."

"Natural indigo used to be one of the most "important industrial products of India. More "than 1,200,000 natives were employed in its "preparation. The recent production of synthetic "indigo in Germany threatens this industry with "utter ruin. Already more than two-thirds of "the world's consumption are supplied with the "artificial product by two German colour works. "We have granted to a foreign patentee a British "monoply, who in return ruins an important "industry with a turnover of £3,000,000 per "annum. Thus do we foster foreign labour, and "assist the development of foreign industries. "The patent not being compulsorily worked here, "there exists at its expiration neither the skilled "labour nor the special plant and machinery "adapted for the purpose, nor any organised "agency for the distribution of the manufactured "goods."

Whether the coal-tar colour industry can ever be retrieved (it was once exclusively British) is a

matter of doubt. The German combination, with its control of the market, and with its capital of twenty millions sterling, is a formidable opponent to be challenged by private enterprise. It is useless to bewail this cut-throat international competition. Great nations must live by great industries, and individual manufacturing concerns like THE UNITED ALKALI COMPANY must be in a position to compete effectively in the world's markets or they must succumb.

Without entering upon the vexed question of retaliatory measures, much can still be done to foster scientific industry. Inequitable patent laws which have made unnecessary gifts to the foreigner of extraordinarily valuable monopolies should be revised. The manufactures in which pure non-methylated alcohol is requisite are practically strangled at their birth, and should be freed from fatal restrictions. Certain dyes, drugs, photographic chemicals, explosives, lacquers, and other substances such as xylonite (celluloid), which require absolute alcohol for their production, cannot be prepared profitably in this country. (The regulations which came in force on 1st October last, only in part meet the needs of the fine chemical industry, although it is stated in *The Times* of 26th September, 1906, that the present concession will enable British manufacturers to make over a hundred chemical products hitherto unable to be produced economically). A distinguished German chemist has declared that "the man who starts to manufacture here, or



"Wigg" Works, Runcorn, on the Ship Canal, looking West.

anywhere, without a free use of alcohol in the preparation of dyestuffs, is working with one arm tied." Lastly, the rewards for services to the national industries in the domain of scientific achievement, should be made equal to those in other branches of the country's service.

The United Alkali Company embodies in its component firms everything that is historic in the rise and development of the chemical industry in Great Britain. The preceding chapters have referred by name to only a few of that long succession of illustrious inventors and pioneers who have contributed to the building up of this great national asset. The half has not been told. Nevertheless, if these pages do nothing more than portray the nature of the silent, bloodless, yet remorseless strife now proceeding, and if the story here told leads only to a clearer conception of the burdens under which this industry labours, and the necessity for removing all unnecessary handicaps, the object of these chapters will have been accomplished.

THE UNITED ALKALI COMPANY

LIMITED

Were awarded the "GOLD MEDAL," CHICAGO, 1893;
"GRAND PRIX," PARIS, 1900;
"GRAND PRIX" and "TWO GOLD MEDALS," ST. LOUIS, 1904;
"GOLD MEDAL," CAPE TOWN, 1904-5;
"GRAND PRIX," LIÉGE, 1905;
"GRAND PRIX," MILAN, 1906.

THE FOLLOWING IS A LIST OF THE CHIEF OF THEIR MANUFACTURES:

Acetate of Soda.
Acetic Acid—Commercial.
,, Glacial.
,, Vinegar.
Acetone.
Acetone Oils.
Ammonia Alkali (all strengths).
Arsenic.
Bi-Carbonate of Soda—
High Strength.
Mineral Water Quality.
Bi-Sulphite of Soda.
Bi-Sulphide of Carbon.
Bleaching Powder.
Calcium Carbide.
Carbonate of Potash.
Caustic Potash.
,, Soda, 60% to 78%
,, ,, Liquid.
,, ,, Powder, 98%
Chlorate of Potash.
,, Soda.
,, Baryta.
Chloride of Ammonium (Refined).
,, Calcium.
,, Lime.
,, ,, (Sanitary).
,, Magnesium.
Chloroform.
CHLOROS (Liquid Disinfectant).
Copper—B.S. and G.M.B.'s, &c.
,, Precipitate.
Crystal Carbonate.
Cyanides.
Diamond Soda.
Fertilisers.
Glycerine.
Hydrochloric Acid—Common.
,, Purified.
(Commercially free from Arsenic.)
Hypochlorite of Soda.
Hyposulphite of Soda.
Ketone Oils.
Laundry Bleach.
Manganate of Soda,

Manganese (Recovered).
Muriate of Ammonia.
Nitrate of Ammonia.
Nitric Acid.
Pearl Ash.
,, Dust.
Pest Killer, Strawsonite—
"Charlock" Brand Sulphate of Copper.
Purple Ore.
,, Briquettes.
Rectified Vitriol.
Sal Ammoniac.
SALT—White.
,, Rock.
,, Lump.
,, Ground.
Silicate of Soda.
SOAPS—Hazlehurst's
"Red Maid" Laundry.
"Cashmere" Toilet.
"Protector" Carbolic.
Soda Ash—
Ammonia (all strengths).
Le Blanc ,,
Soda Crystals.

Spraying Materials.
Sulphur—Rock.
,, Roll.
,, Flowers.
Sulphuric Acid—Brown.
,, Best Brown.
,, Rectified.
Sulphate of Ammonia.
,, Copper.
,, Soda or Saltcake.
Sulphide of Sodium.
Sulphydrate of Calcium.
,, Sodium.
Superphosphates.
TAR PRODUCTS—
Pure Benzene, Toluene, Solvent Naphtha.
Benzole, 50% and 90%
Brick Oil, Creosote Oil and Salts.
Crude Carbolic Acid.
Pitch, Prepared Tar and Black Varnish.
Mono Chlor Benzene and Mono Chlor Toluene.
Di Nitro Chlor Benzene.

THE UNITED ALKALI COMPANY
LIMITED,

Head Offices: 30, JAMES STREET, ... LIVERPOOL.

TELEGRAPHIC ADDRESS: "UBIQUE," LIVERPOOL.

TELEPHONE NOS. 6585 AND 5001 LIVERPOOL.

All Communications must be addressed to the Company.

LIVERPOOL:
Gilbert G. Walmsley, Printer, 50, Lord Street.

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